EFFECT OF POLLUTANT EXPOSURE
AMBIENT AIR IN CHILDHOOD AND ADULTHOOD

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ABSTRACT

This study explored multivariate modeling to describe the relationship between respiratory health and ambient air pollution in three Los Angeles communities using data of respiratory symptoms and pulmonary function collected for the UCLA Population Studies of Chronic Obstructive Respiratory Disease (CORD). Log-linear analysis and expert judgement were used to select outcome measures. The modeling approach included linear and logistic regression analysis and focused on adult non-commuting females whose ambient air exposures were best represented by air quality monitoring stations in the community of residence. A model was also developed for use in calculating sample sizes necessary for such studies. Estimates indicated that a small number of subjects was sufficient to identify differences in FEV_1 or FVC equivalent to a cigarette smoking effect. FEV_1, FEV_1/FVC, and delta N_2 were selected as outcome measures. Multivariate analysis did not provide a clear model which improved on earlier analyses. Effects of birthplace or current abnormal respiratory health as indicators of potential "susceptibility" to air pollution were not identified. These results were judged indicative of limits in the data available for estimating ambient air exposures for individual study subjects.

I. INTRODUCTION

A. Background

This study was designed to explore ways to develop models which would best describe the relationship between respiratory health and ambient air pollution in three Los Angeles communities. Cohorts of residents of these geographically defined study areas had been formed from cross-sectional surveys carried out between 1972 and 1977[1-4]. The demographic characteristics of the three study areas along with the sex and race distribution of those who completed the baseline testing are given in Tables 1 and 2 [2,5,6]. The study areas included Lancaster (exposed to minimum levels of man-made pollutants), Long Beach (exposed to SO_2, particulates and other primary pollutants) and Glendora (exposed to high levels of photochemical oxidants, particulates and SO_4). These three communities were all retested approximately five years after baseline testing.

This is a continuation of the UCLA Population Studies of Chronic Obstructive Respiratory Disease (the CORD Study). In earlier cross-sectional analyses [3], the residents of the three communities were classified by age, sex, and smoking status. Comparisons of a large number of pulmonary function measures from such groups in the three communities showed that more of the worst communitry average pulmonary function values occurred in Glendora than in the other two communities. The number of worst community averages was also high in Long Beach, but not as high as in Glendora. No worst community averages occured in Lancaster, which had significantly lower levels of air pollution. Cross-sectional analyses of changes over the five years in the frequenncy of pulmonary symptoms and of rates of change of pulmonary function measures were also performed. The majority of these analyses indicated better pulmonary fuction in residents of Lancaster than in Long Beach and Glendora. Wherever there was statistically significant difference in pulmonary fuction or symtoms between communities, the better values of pulmonary function or lower frequencies of symptoms occurred in Lancaster, the low pollution area. Changes over five years in the frequency of recorded symptoms and results of lung function tests were also studied in these same comunities [7]. The majority of test results were more favorable in residents of the low pollution area (Lancaster) than in the other two areas. In no instance was a significant difference noted which was not more favorable to the low pollution area.

B. Objectives

The analytic objectives of the project were: to examine further the association of baseline pulmonary function parameters and estimates of air pollution exposure while accounting for confounders and effect modifiers; and to examine the association of changes in these parameters and estimates of air pollution exposure while accounting for similar confounders and modifiers. This was to be carried out using multivariate analysis approaches in hopes of identifying models which described this association while simultaneously accounting for other explanatory variables.

One particular focus was planned for groups which might be considered "susceptible" or "sensitive" to respiratory tract insults. For example, persons with low lung function, with a history of asthma, or with a history of cigarette smoking may sustain greater damage when exposed to ambient air pollutants. Therefore we tried to define such groups from existing information and determining whether their response characteristics were different from those of the remainder of the study population.

In addition, there was a specific hypothesis about migration and respiratory health to be tested. The hypothesis was that individuals presumably exposed to high levels of pollutants in the air during childhood have a more rapid rate of decline in lung function parameters than individuals not so exposed.

This large population-based cohort was also used to estimate the number of subjects required to detect a significant difference between subjects exposed and unexposed to ambient air pollution. Such estimates cannot be computed directly, since there is no accepted magnitude of effect associated with such pollution. Instead, an appropriate, arbitrarily selected, magnitude of effect was to be identified and used in the context of the variability of the different measures of pulmonary function employed to carry out the statistical power analysis.

Finally, it was the intent to explore the possible development of groupings of pulmonary function parameters which might show more association with air pollution exposure than the individual pulmonary function parameters.

II: Methodology

A. Establishment of cohorts

Prior to this proposal, cohorts of residents of three geographically defined areas selected to be exposed to different levels and types of air pollutants had completed baseline lung function testing at a Mobile Lung Research Laboratory[1-3,8]. Each member of these cohorts completed a modified NHLI respiratory questionnaire, volume spirometry with electronic recording of the entire flow volume curve (air vs. helium/G_2), the single-breath nitrogen washout curve, and whole body plethysmography. The individual cohorts ranged in size from 3403 to 4509 residents. A total of 15,164 individuals were examined at baseline.

The geographically defined areas were selected to have similar distributions of socioeconomic factors and racial groups, to contain or be adjacent to a continuously monitoring station of the Southern California Air Quality Management District, and to be historically exposed to different types and levels of pollutants in community air.

The interlaboratory variability of the test procedures was evaluated by reexamining, at the UCLA Pulmonary Function Laboratory, a 3% probability sample of residents completing lung function testing at the Mobile Lung Research Laboratory[2]. Intralaboratory variability was evaluated by immediate retesting of every tenth participant at the Mobile Lung Research Laboratory and by reexamination of 100 residents of each study cohort four times a year[1,2,6,9]. Details of the recruitment and test procedures used for the baseline studies have been reported[1,2,6].

B. Relocating Cohorts

Relocation of members of the cohorts was the responsibility of the field coordinator and the neighborhood representatives who had been selected from the community being tested. In many instances these were the same neighborhood representatives who were responsible for the successful recruitment of residents at the time the cohorts were originally formed.

The current residence of members of the cohorts in the three areas had been updated annually. The return form included a request for the name and address of a "contact person" who would know how to reach the participant in the future.

Letters announcing the initiation of reexaminations in each area were sent to the most recent address with the request for notification of forwarding address and return postage guaranteed. Current addresses for those individuals for whom there was no forwarding address were sought through the designated contact person, canvassing of neighbors, a check of the Department of Motor Vehicles' driver and vehicle registrations, review of telephone directories for areas designated by neighbors, and finally by a review of death tapes.

Letters were sent to all members of the original cohort still residing in the area indicating that retesting of all participants was currently underway in their respective community and that they would be contacted by a neighborhood representative who would update their household roster and set up an appointment for each family member to revisit the Mobile Lung Research Laboratory. As previously, the mobile laboratory was located within walking distance of the resident's home.

For those individuals who did not keep their appointments, a follow-up telephone call was made immediately. If unsuccessful, repeated attempts were made to reschedule testing for residents.

Individuals who had changed residence since the original testing fell into three categories: those remaining within the study area or adjacent to it, those moving out of the Southern California area, and those lost to follow-up. Individuals remaining within the study area or in immediately adjacent areas were visited and scheduled in the same manner as individuals within the study area who had not moved. Respiratory questionnaires with additional questions on reasons for moving were sent to those moving out of the Los Angeles area. The cover letter also asked them to contact us if they would be near the study area in the future so that we could arrange to retest them.

The initial letter to residents who remained in the study area or nearby contained a return envelope and form requesting their current telephone number so that the neighborhood representative could call them back in order to work out the most acceptable time and place for retesting them. In order to encourage their participation the neighborhood representative offered to pay travel expenses for retesting. For those individuals who did not indicate their current telephone number, their number was sought by review of phone directories for the area, directory assistance and reverse directories.

Concurrent with the retesting of the cohorts in Long Beach and Glendora we requested that articles concerning the program appear in the local newspapers and that public service announcements be made over the local radio and television stations.

The key member of the program staff involved with recruitment of residents was the neighborhood representative. They were selected from among applicants on the basis of their performance in the training program. Whenever possible, the same neighborhood representatives who worked during the baseline screening in that community were rehired.

C. Respiratory evaluation and lung function testing

1. Interview schedule

The interview schedule included an updating of the symptom, smoking, respiratory disease, residence and occupational histories and, in addition, contained questions about commuting patterns, percent of time indoors and outdoors, and type of heating used in the residence (see Appendix A).

Individuals were considered to have definite criteria of wheezing if they reported their breath ever sounding wheezing or whistling on more than 19 days in a year and/or they had ever had attacks of shortness of breath and wheezing. Individuals were considered to have asthma bronchitis and/or emphysema if they had been told by a physician that they had one or more of these diseases.

Smokers were individuals who had smoked within one year of baseline testing and did not change smoking habits during the interval between baseline and follow-up. Individuals who reported stopping or started smoking in the interval between baseline and retesting were classified separately.

2. Tests of lung function

The following tests of lung function were administered to members of the cohort (listed, for those relevant to the current study, in the order in which they were performed):

(a) Height, weight, pulse and blood pressure measurement

(b) Single-breath nitrogen washout curve (multiple trails): $N_{2750-1250}$,

(c) Electronic spirometry (multiple trials with permanent recording of the entire flow volume (FEV_1, FVC); forced expiratory flow rates instantaneous flow rates at various percents of FVC (V_{25}, V_{50}, V_{75}, and V_{max})

D. Test-retest variability

Intra-laboratory variability of the tests was estimated by retesting every 10th participant within ten minutes. Seasonal variability had been estimated by retesting 100 participants three times during the year. No differences were found. Inter-laboratory variability was estimated by retesting a 3% sample at the UCLA laboratories[2,6,10,11].

E. Validation and quality control

1. Standardization and calibration

Before initiation of retesting the test equipment on the Mobile Lung Research Laboratory was cross-calibrated to equipment at the UCLA Pulmonary Function Labortory employing volunteers who went through the same tests in a random order at both these laboratories.[2] In addition, all equipment on the Mobile Lung Research Laboratory was Calibrated before, during and after each day's testing and the test results reviewed quarterly.

2. Validation

To determine if calculation of rates of change in lung function test results were related to differences in laboratory procedures all members of the cohort who were included in the original 3% probability sample which underwent retesting at the UCLA Pulmonary Function Laboratory at the time of baseline screening were invited once again to undergo further testing at the UCLA laboratory. At the time of the baseline examination, approximately one-half of this sample was randomly selected from all residents 18 years of age or older who completed testing at the Mobile Lung Research Laboratory; the other one-half were selected on the basis of definite or probable respiratory abnormalities according to the results of the Mobile Lung Research Laboratory tests.

Retesting in the validation laboratory of this original cohort (which had already undergone validation studies at the time of the baseline examination) was important from the standpoint of determining whether changes in interlaboratory differences had occurred which could reflect changes, or "drift," in the characteristics of the field instrument over the five-year interval between the baseline and present examinations. Although cross-sectional comparisons could be made at baseline and retest, any differences observed could be due to differences in the populations tested because of aging and dropouts. Comparisons of the change in individuals tested twice, therefore, gave a better evaluation of the comparability of measurement of change in the two laboratories.

We also invited for retesting in the validation laboratory an additional randomly selected sample of individuals 18 years or older who had completed retesting in the mobile laboratory. The retesting of these individuals who had not previously undergone validation studies served as a satisfactory mechanism for determining the current reliability of the field laboratory; more important, by permitting comparison of current field laboratory-reference laboratory differences with those observed at the time of baseline testing, such retesting in the UCLA laboratory provided a needed check on the occurrence of "drift" in the field instrument. As an inducement individuals selected for validation studies at UCLA were offered a $10.00 fee in addition to travel expenses. Subjects underwent the same studies that were performed in the mobile laboratory as follows:

(a) Respiratory questionnaire (cohort project interview schedule)

(b) Spirometry (using a 10-liter Stead-Wells spirometer) and spirometry and flow-volume curves (generated by an 1.1-liter rolling-seal electronic spirometer: Cardio-Pulmonary Instruments, Inc., Model 220) from which the following indices were calculated: slow vital capacity FVC, FEV_1, $FEF_{200-1200}$, FEF_{25-75}, peak maximum flow rate (V_{max}) and maximum flow rates at 25%, 50% and 75% of forced expiration and maximal voluntary ventilation. Calculations were made using the tracing representing the best effort on the basis of FEV_1, if the latter was associated with an FVC which was at least 95% of the best FEV_1.

(c) V_{max50}, V_{max25}, and volume of isoflow calculated from maximal expiratory flow-volume curves generated during breathing of air and an 80% helium-20% oxygen mixture.

(d) Helium-dilution lung volumes using a 13.5-liter spirometry (Warren E. Collins, Inc.) for determination of functional residual capacity, expiratory reserve volume and residual volume. Although this test was not performed in the field laboratory, it was included in the battery of validation laboratory tests because it provided a further check on the validity of plethysmographically determined thoracic gas volume and on the total lung capacity from the single-breath nitrogen washout for determination of closing capacity.

(e) Closing volume, closing capacity and slope of phase III of the single-breath nitrogen washout curve

$N_{2750-1250}$ and N_2/liter using an electronic spirometer, a rapidly-responding nitrogen analyzer Cardio-Pulmonary Instruments, Inc., Model 410), and a multichannel oscilloscopical recorder (Electronics for Medicine, Model DR-8).

(f) Airway resistance and thoracic gas volume at functional residual capacity using a 600-liter constant-volume body plethysmograph (Warren E. Collins, Inc.).

(g) Single-breath diffusing capacity for carbon monoxide using a water-seal spirometer and bag-in-box system (Warren E. Collins, Inc.) with helium and infra-red CO_2 analyzers (Beckman Instruments, Model LB2). This test, although not performed in the mobile laboratory, served as a useful indicator of probable emphysema in individuals with airflow obstruction.

(h) End-expired CO using an electrochemical CO analyzer (Ecolyzer Series 2000).

F. Data management

A computer-based data management system was designed for test results from the baseline studies and from retesting of the cohorts. The base file contained the household roster. The second-level file contained results of the field questionnaire and pulmonary function tests from the baseline testing in each area. Household roster information on specific individuals undergoing field testing had been incorporated into this second-level file. The third-level file contained the results of field and validation lung function tests for the 3% probability sample invited to undergo retesting at the UCLA laboratory at baseline. The fourth file included name, address, telephone and identification numbers used for follow-up notification for the retesting of cohorts. This was the only file which contained both the name and identification number of the individual residents and has been kept under limited access. The fifth file included the air pollution and climatologic data obtained from the four monitoring stations of the Southern California Air Quality Management District.

At the time of retesting new files were created to include both baseline and retest information. All individuals were included in the new files regardless of whether they completed retesting. For those individuals not completing retesting the cause for non-completion was included in the file.

Additional files were created for the 10% sample undergoing immediate retesting at the mobile laboratory and the 3% sample retested at UCLA. These files were used to estimate the intralaboratory and interlaboratory variability of the test procedures. Computer files of air pollution and climatologic data for each of the four stations of the southern California Air Quality Management District and other sources were maintained for the entire period of field testing.

Data from the modified NHLI respiratory questionnaire and the household roster were collected on self-coding forms. That data and the data from the Mobile Lung Research Laboratory were entered into computer tape. Data from electronic volume spirometry and the single-breath nitrogen washout curve were recorded directly onto 9-track computer tape which was compatible with the IBM system being used at UCLA. A computer program had been developed which selected the best breath for determination of the spirometric indices[6]. In the event of breakdown of the recording at the Mobile Lung Research Laboratory, a hard copy backup was maintained on all testees. Errors of the recording device were minimized by rapid rechecking of all data tapes from the mobile laboratory within 24 hours of retesting and before testing began the following day. Editing of data was done by computer using a program to identify outlying or unusual values. These were printed for verification and/or corrections.

An important component of this study was the cooperation of cohort members. In order to maintain this cooperation a rapid notification system had been developed which identified individuals with abnormal responses. This program automatically generated letters of notification, providing a general assessment in lay terms of the results of the lung function testing to the testee. The results of the specific tests of lung function were also sent to the physician designated by the participant.

G. Monitoring of air pollution levels

The quality of air in the three communities was continuously monitored by stations of the Southern California Air Quality Management District (formerly the Air Pollution Control District) of Los Angeles County as follows:

Lancaster, Station 82

Long Beach, Station 72

Azusa (Glendora), Station 60

Each of these stations recorded continuously (except for calibration and chemical restocking periods) the following: total oxidants, nitric oxide, nitrogen dioxide, total oxides of nitrogen, total hydrocarbons and nonmethane hydrocarbons (not in Long Beach), carbon monoxide, sulfur dioxide (not in Lancaster), and total particulates. Twenty-four hour sulfates were recorded from 1977 in Long Beach and Glendora.

Description of the instrumentation employed, technical maintenance, calibration techniques and validation procedures, and the frequency with which these were done are contained in the Quality Assurance Plan fro Ambient Air Monitoring, July 1977, Technical Services Division/South Coast Air Quality Management District.

The output of the Southern California Air Quality Management District is reported by contractual arrangement to the California Air Resources Board. The contract requires the following schedule of calibration of the monitoring and analytical instruments:

"All air monitoring instruments shall be calibrated by either the State or by the Contractor in accordance with procedures acceptable to the State. The Contractor shall provide copies of its current instrument calibration procedures and chemical analysis procedures for all pollutants monitored upon submittal of this contract, but in no case later than 90 days after receipt of the contract. If, in the State's opinion, the Contractor's procedures are significantly difference from State procedures, the Contractor shall use State procedures or furnish the State with evidence of equivalence. In addition, the State shall have the discretionary right to conduct referee calibrations for each parameter at the Contractor stations.

"The Contractor shall calibrate air monitoring and analytical instruments on at least the following schedule:

Oxidants (Ozone)	Semi-Annually
NO, NO_2, NO	Annually
NDIR CO_2	Annually
FID Total Hydrocarbon	Annually
SO_2	Annually
Hi-Vol	Semi-Annually
COH (flow rate calibration)	Semi-Annually
Sulfate and Nitrate Spectrophotometers - Concentration	Quarterly
Sulfate and Nitrate Spectrophotometers - Spectral Response	Semi-Annually
Lead, Spectrophotometer - Concentration	Quarterly

"Instruments shall be recalibrated after major repairs or modifications. A copy of each calibration report shall be submitted to the State within thirty days of the instrument calibration date. Information on the calibration report cover shall include: parameters monitored; method of calibration; manufacturer, model, and serial number of instrument; date of calibration; and results in percent deviation from true, both before and after adjustment, and percent deviation, from last calibration.

"For calibrations of carbon monoxide and total hydrocarbon analyzers, the Contractor agrees to use carbon monoxide and methane span gases traceable to State or NBS standards. The Air Resources Board will provide compressed gas cylinders of the proper concentrations for multi-point calibrations upon request."

The validity of air quality data with which physiologic data was related was, therefore, at levels satisfactory to EPA and the State of California Air Resources Board technology.

The ability of fixed monitoring stations to quantify air quality levels in neighborhoods around the station (representativeness) had been evaluated by several techniques in the past. Mobile laboratories have simultaneously sampled air at various radii around the stations and compared data with those of the station. Study of levels in a series of stations, with relation to windflow patterns, had generated a body of data concerning the duration and flow of concentrations of substances. Isopleths have been developed for various pollutants occurring in the Southern California Air Basis[12,13]. Studies to further interpolate values between stations and to provide more precise "neighborhood" estimations were also done by the Technical Services Corporation[14]. A summary table of representativeness for census tracts proximate to the monitoring stations is shown below:

Oxidant	Uniform over 10-20 miles
NO_2	Uniform over 5-10 miles
SO_2	Uniform over 10-20 miles, except where power sources within the range contribute
SO_4	Uniform over 15 miles
CO	Not uniform
Hydrocarbon	Uniform over 5-10 miles, except where power sources within the range contribute

Because we were interested in the effects of long-term exposure to pollutants, we selected study areas historically exposed to very different levels and types of pollutants which were located either adjacent to or within a short distance downwind of the stations of the Southern California Air Quality Management District cited above which continuously measured levels of selected pollutants[1,3,8].

In the Long Beach study area no residence within the study area was more than 1/2 mile from the monitoring stations. Most of the residents of the Lancaster study area lived within 1 mile of the monitoring station. No residence in the Glendora study area was more than 4 miles downwind from the monitoring station in Azusa used to estimate pollutant exposures occurring in that study area. Measurements of total oxidants and other major pollutants except carbon monoxide, therefore, may slightly underestimate exposures occurring in the Glendora study area. Each of the study areas except Lancaster was less than one square mile in area and had no topographical barriers between it and the monitoring station. In Lancaster the majority of the population in the study area was contained within a one square mile area nearest the monitoring station. The mean of the annual daily maximum measures for six pollutants are displayed for each of the three communities in Figures 1a-1c.

There are several areas in which documentation of pollutant exposures have been inadequate. Hydrocarbon and particulate levels were not regularly measured at the Long Beach station but evidence from another study and the location of the station downwind from the petrochemical industry suggests that levels of hydrocarbons and particulates were high. Particulates have been measured using the high volume sampler technique. Techniques with separation by particle size would, of course, have been more helpful. although isopleth studies have provided estimates of the representativeness of measurements of particular pollutants made at a fixed monitoring station, validation of these estimates using a mobile or portable sampler to measure levels concurrently was not carried out systematically.

H. Analyses

The major objective of the analyses was to determine whether there was a relationship between changes in lung function test results in areas exposed to different levels and types of air pollution--Los Angeles County. A number of issues in the analysis of these cohort data were addressed in "Changes in Lung Function and Exposure to Oxidants" ARB Contract # AO-133-32. Those related to potential problems of misclassification, measurement of pollutants, characteristics of the participants, response characteristics and the effect of acute exposures were dealt with in that report and are only summarized here.

1. Variability

The variability of test procedures may be due to variability in the procedures themselves (instrumentation), variability in the individual being tested, variability between a group of individuals, and/or variability due to outside factors such as seasonal factors.

The intralaboratory variability of the spirometry field tests was evaluated by comparison of initial and retest values on the 10% sample of participants who underwent immediate retesting within several minutes of the original testing. The interlaboratory variability of the field tests was measured by direct comparison with observations made in a 3% probability sample retested at the UCLA Pulmonary Function Laboratory. Corresponding measurement in the field and in the UCLA laboratory were compared individually as well as by groups of variables. Scatter diagrams and indices of co-relationship were obtained and studied. Test-retest results were very similar especially for the major spirometric tests (FEV_1, FVC, $FEF_{25-75\%}$).

Variability in the results of field laboratory tests related to changes over time in the performance characteristics of the measuring of calibrating instruments and/or in technical personnel could have led to consistent differences in field test results. Such differences might then be erroneously interpreted as representing real physiological changes over time in the cohort undergoing re-examination. Comparison of current interlaboratory (i.e., field laboratory-UCLA laboratory) variability with that determined at the time of baseline testing served as a needed check against such consistent errors.

2. Characterization of non-respondents

The results of retesting of lung function in the areas might have been affected by the characteristics of respondents vs. non-respondents. Therefor, individuals who have refused to undergo retesting, who have moved too far from the original study to be tested, who had been lost to follow-up, or who were too ill to be retested were characterized on the basis of reasons for non-response, demographic, familial and occupational factors, respiratory history and lung function performance at baseline.

To determine if there were differences between those who were tested and not retested the mean observed/expected value for FEV_1 among those retested and those not retested was computed. The mean FEV_1's for those who refused was lower in each study area than among those who were retested or who were not retested by virtue of moving. The overall mean FEV_1 values among those retested was only slightly greater than the mean value for those not retested suggesting that the values observed for change may be a small underestimate of the actual rates of change for the entire cohort had it been completely retested.

3. Effect of acute exposures

Although the primary objective of this study was to determine the relationship of long-term exposure to specific types and levels of pollutants in community air and respiratory health and the predictiveness of specific tests of lung function, the relationship of acute exposure to specific pollutants was evaluated by correlating the lung test performance of individuals to levels of various pollutants on the day of testing. No consistent association was found in these data.

III. ANALYTIC STRATEGIES

For the purposes of this study the population investigated was limited to those subjects in three communities (Long Beach, Glendora and Lancaster) who were surveyed in both the baseline and in the first followup resurvey. Furthermore, the population was limited to adults, since there was no way to estimate whether lung size changes in juveniles were related to unmeasured growth spurts and because questions exist about whether cigarette smoking in juveniles is properly ascertained. The analytic issues addressed by this report concentrate on: 1) factors which might impact on the environment of the population (job, commuting, time spent outdoors, etc.); 2) Geographic origin of study subjects and its influence on early air pollution exposures; 3) use of cigarette smoking habit information; 4) the development of the basis for sample size estimates for studies of this type; 5) the selection of alternative outcome variables; 6) the consideration of possible groups of "susceptible" subjects who could be identified as being at special risk of suffering effects of ambient air pollution or other insults to the lung; 7) the examination of multivariate approaches to modeling the effects of ambient air pollution or other insults to the lung.

A. Examination of Modifiers of Subject Environments:

Several items were collected on the survey questionnaires which explored variations in living habits and patterns which might affect the ambient pollution exposure of study subjects. These included:

1) Commuting time. Data were collected as a continuous variable using number of minutes reported by each subject. Distinction was not made between one-way and round trip but it appears it was answered as round trip.

2) Time spent out-of-doors on weekdays and weekends. These data were collected in categories of time spent (<1, 1-3, 4-6, 7-9 and >9 hours/week or weekend)

3) Job type and location. These data were collected by current type of industry and job title (coded according to a list of 99 options), location of work (zip code), duration of employment in current job (categories of <1, 1, 2-5, 6-10, 11-15, 16-20, 21-25, and >25 years), time spent outdoors at work, air modification at work, and a series of questions about use of selected materials, employment in specific industries or jobs, along with duration and selected material exposures.

4) Type of home air treatment, heating, and fuel. These data were collected on several different types of air treatment (including air conditioning and humidifying), type of heating system and, in two of the three communities, the type of fuel used for heating and for cooking.

In order to examine the impact of community air pollution on outcome variables these variables were considered for inclusion in the multivariate models.

B. Geographic Origin of Study Subjects:

An initial hypothesis was that the birthplace of a subject and the geographic location of the subject during physical growth might be important predictors of the probability of response to oxidant air pollution or of the level of that response.

To examine this hypothesis, the residential history of each subject was independently coded along with responses to the question "Where did you spend most of your childhood?" The population size of each city or town was obtained from census data for the appropriate era and these data were merged. The census data are available at ten year intervals so each location was assigned the population associated with it for the five years before and the four years after each census year.

Consideration was given to separately estimating relative air pollution levels as well as the type of pollution (oxidant v. reducing) for each location. There are, however, no adequate data for almost all areas of the country, until quite recently, and none before about 1965. Therefore, it was accepted that, in general, population size would be the only surrogate to estimate pollution level over the years.

C. Use of Cigarette Smoking Habit Information

A detailed cigarette smoking history was collected for all subjects at both surveys. These data permitted consideration of smoking habit, amount smoked (pack years), and time since quitting for those who had stopped smoking. For the purposes of the analysis the subjects included in the follow-up evaluation were limited to those who had not changed their cigarette smoking habit during the course of the study. Those quitting smoking were defined as those who had ceased regular cigarette smoking a minimum of one year prior to the baseline evaluation.

D. Sample Size Estimation

Cross-sectional and prospective community-based studies of air pollution effects require substantial sample size to permit identification of a general impact of air quality on pulmonary function. The data from this study were employed in order to estimate the size of such samples needed in future studies. This effort was carried out in a two stage process.

First, several different models were explored for adjustment of pulmonary function, accounting for the gender as well as the different ages and heights of the subjects. These models were compared both in terms of the amount of variance explained by each and by direct inspection of the impact each model had when applied to the extreme values of the subject population (very short or very tall, very young or very old).

After selection of the most appropriate model, the data were used to calculate the sample sizes necessary to achieve specified powers for detecting differences. In order to accomplish this, it was necessary to select a target difference. Since a level of impact of air quality sufficient to attract both scientific and regulatory attention was believed to be of the order of magnitude of a cigarette smoking effect, it was decided to compute sample size estimates which could detect differences observed between the current smokers and non-smokers in the study population. It can be argued that the expected differences due to air quality may be half as large as those observed between current and never smokers. In that case, however, the sample sizes necessary would be simply four times the sample sizes developed.

E. Selection of Outcomes:

The type of outcome variables collected in the two surveys in each community limited the choice of outcome variables. There were, however, a large number of pulmonary function tests used, so that some investigation was required to select those which provided the least redundant and therefore the most independent information. Three approaches were used to arrive at a final selection:

1) A principal components analysis carried out on the several pulmonary function test measures.

2) Log linear analysis seeking significant associations between selected pulmonary function measures which were expected to be somewhat redundant.
3) Informed judgement of those experienced in lung function studies of individuals and populations. This was necessary so that any result from the first two efforts would meet with the essential criteria of biological plausibility and interpretability.

F. Considerations of "Susceptibility"

It has been suggested that a portion of the general population is, in some way, susceptible to insults to the lung and will experience a differentially excessive impact of exposures to agents toxic to the lung. An example of such a condition, although rare, is the homozygous genetic trait of being deficient in alpha-1-antitrypsin. Such persons are at unusual risk of developing emphysema. Retrospective analysis of smoking populations has suggested that some cigarette smokers experience unusual acceleration of decline in lung function over time in contrast to equivalently exposed peers. The source of this "susceptibility", however, has not been identified.

In this study we attempted to classify subjects into groups which might indicate likelihood of a greater response to an ambient air effect ("susceptibility"). For example, those with a physician diagnosed history of asthma might be expected to experience long term effects of ambient air pollution differently from those who are not asthmatic. Similarly those with reduced lung function at baseline may be expected to suffer accelerated loss of lung function compared with those with normal or above normal function at baseline (although an expected regression to the mean may make this group heterogeneous enough to prove not useful). Thirdly, those who are symptomatic at the outset of the study may be more likely to show abnormal changes in function over time.

G. Multivariate Modeling for Respiratory Effects

These data have already been examined by stratified analysis taking advantage of the large population size to examine for a community (air quality) associated effect on pulmonary function and respiratory symptoms. The results are reported in the ARB contract "Changes in Lung Function & Exposure to Oxidants"[7].

In this study these same data were to be used to develop a multivariate model which would simultaneously consider the several independent variables believed to have some impact on the respiratory health effects outcome variables.

The approach included linear regression analysis using standardized pulmonary function measurements as the dependent variable and logistic regression analysis after classifying these same measurements into normal and abnormal categories.

IV. RESULTS

The study was designed to examine air quality impact on the general population. Since a decision was made to estimate individual exposures to varying air quality through the use of area-specific air monitoring station results, it was essential that these results be appropriately assigned to each study subject. The air pollution exposure data available on subjects, however, was limited to the community of residence. This led to a decision to limit the study population accordingly.

A. Selection of Study Focus

Tables 3 and 4 show the number of subjects who were surveyed successfully twice in each of the three study communities according to smoking history. Since Table 4 contains only subjects whose smoking history was the same at both surveys the numbers are somewhat smaller than those reported in Table 3. The vast majority of males and an important minority of females among those listed commuted away from their neighborhood reference air monitoring station which made the targeted air monitoring station data inappropriate for them for a substantial portion of each day.

Initially, the plan was to attempt to build an ambient air exposure profile for each subject while accounting for daily activity. This would adjust each subject's ambient air exposures for the times when the community air monitoring station was not appropriate for estimating exposure. To this end the plan was to use information from an estimate of exposure while at home (adjusted for type of air treatment in the home, type of fuel used for cooking, and amount of time spent out of doors); an estimate of the amount of time spent commuting and amount of time spent at work (using an exposure estimate from an air monitoring station close to work; an estimate of the amount of time spent out-of-doors while at work; and an estimate of the types of work exposures experienced if the job was other than 'white collar').

This approach had to be abandoned, however, for a number of reasons. When consideration was given to using the air monitoring station which was closest to each commuter's place of work, it became clear that this was not likely to be successful. As described in the Methods section, the selection of the communities and their associated monitoring stations had been made with careful consideration of 1) residence in close proximity to the station, 2) differences in the types of pollution represented by the three stations, and 3) lack of important physical barriers within the community which would invalidate the assumption that the station measurements could serve as a reasonable approximation of the air quality in the vicinity of the home.

The workplaces of many of the male commuters were not as close to air monitoring stations as their homes were to the three community stations. In a number of instances there was no appropriate station near the work site. In addition monitoring stations near work sites included those where physical barriers presented a problem. Finally, the amount of data to be collected from each air monitoring station was substantial and could easily have led to an inappropriate assignment of resources.

It still might have been valuable to include males in the study in order to attempt an estimate of the combined impact of air quality and occupational exposures. To explore this possibility an analysis of the distribution of the job and exposure histories of the male population was undertaken. Accounting for all males surveyed both times (n = 1365) there were only 338 with mention of any employment in jobs with possible adverse pulmonary exposures or working in industries with such risks (asbestos, baker, cotton, grain, miner, plaster, powders, sand blasting, smelter, stone, and textiles). The largest number mentioned asbestos (104) of which 60% indicated five or more years in such work. Next most common was the undefined term powders (63) with a similar 60% reporting five or more years employment. The remaining items were noted at most 31 times (smelter work with 10% of those reporting this work indicating five or more years).

It might have been possible to take these "exposures" into account but for several concerns. There was no documentation of actual exposure. The numbers were small for any specific exposure (except for asbestos). The public awareness of asbestos exposure and cancer risk makes it highly questionable that the asbestos exposure recorded is of the type to be sufficiently high to present a risk of non-malignant respiratory disease.

Given these considerations, it was decided that it was not possible to evaluate the impact of these types of exposures on the male study population, although the subjects would need to be excluded if unreasonable confounding of any non-work associated effect on respiratory health were to be avoided. After documenting these problems with interpreting the effects of ambient air on the study subjects a decision was made to limit the focus of the study to adult (25-59) females who did not commute (Tables

14A-C). This, of course, substantially reduced the study population, but the decision was judged necessary in light of the above considerations.

B. Examination of Modifiers of Subject Environments:

As indicated under the discussion of selection of study population, a decision was made not to consider work environment as a modifier of home environment ambient exposures. Other such modifiers, however, were considered accordingly.

1. Commuting time

Although the decision was made to concentrate the analysis on females for reasons already discussed, commuting time was examined for males to determine the magnitude of its possible importance. The commuting habits of subjects from the three communities were somewhat different. Those males who were employed full time and who estimated their round trip commute to be up to 30 minutes included 61%, 57% and 53% in Lancaster, Long Beach and Glendora, respectively. When looking at the proportion who commuted for longer than 30 minutes, however, the distributions were not similar. Those whose commute took between 1/2 and 1 hour included 15% for Lancaster while Long Beach and Glendora's proportions were 30%, and 29%, respectively. Therefore, there was a large proportion of commuters in Lancaster who traveled more than one hour per day. In particular 15% indicated they commuted from 1.25 to 1.5 hours per day. In contrast 8% of full time employed males in Long Beach and 10% in Glendora commuted this long.

In order to utilize information on commuting it would be ideal to have estimates of types and levels of ambient air pollutant exposures experienced by each commuter. These probably differ both by type of automobile, use of air conditioning, amount of traffic and whether the commuter smokes or is exposed to smoking during commuting. Such information is not available; therefore, a surrogate for these features was selected to be the number of minutes of commuting.

2. Time spent out-of-doors on weekdays and weekends

In recent years it has become clear that the difference between indoor and outdoor ambient air exposures can be quite large. For example, ozone levels outdoors may be substantially different from those indoors, since wall, furniture and other surfaces capture ozone and reduce ambient levels indoors. It would be desirable to differentiate subjects according to estimates of the amount of time spent outdoors, since this time more accurately reflects the air monitoring station results.

The survey instrument inquired about how much time was spent outdoors during the week and on the weekend for all subjects. These results were distributed according to whether the individuals were employed full or part-time, or whether the person was a student, unemployed, retired, or a housewife. The results are presented in Figures 2a - 2c. As expected almost all housewives, regardless of community, spent at least one hour a day outdoors, while employed males and females spent less time. For the employed persons those from Lancaster spent more time outdoors.

On weekends, in general, all groups spent more time outdoors with males most likely to be outside. The differences between communities were considered by using this categorical measure of time outdoors in the modeling reported below. For this purpose the time spent outdoors on weekdays was multiplied by five and summed with the time spent outdoors on weekend days multiplied by two.

3. Type of home air treatment, heating, and fuel

Some investigators have suggested that there are respiratory health effects associated with residence in homes where natural gas fuel is used for cooking. It can also be expected that air treatment in the home can change the nature of indoor ambient air exposures sufficiently to expose individuals to measurable differences in air pollutant levels. Direct measurements of indoor exposures were not available, but the questionnaire did include inquiries about home air treatment in Glendora homes at baseline and in all homes at resurvey. In Glendora at the time of the second survey a question was also added about the type of cooking fuel used. Since these data were not systematically available for the surveyed population, they were reviewed with respect to their distributions according to other variables of interest. In this regard suggestion of a confounding association with cigarette smoking habit, age at migration to Los Angeles and a measure of susceptibility was being sought.

Distributions of home air treatment and of cooking fuel use were examined among housewives according to community of origin, smoking habit and whether a subject had an abnormal baseline measurement of pulmonary function, whether the subject was born in a Los Angeles community, or outside Los Angeles and whether the subjects born outside Los Angeles moved to Los Angeles before or after age 16. Given the number of variables being examined simultaneously, the number of subjects per cell were rather small. Nonetheless, there was no evidence that the air treatment in the home or the type of cooking fuel (in Glendora only) were differently distributed according to these strata. As mentioned earlier, it would have been preferable to have actual measurements of indoor air pollution to address the effects of different indoor ambient environments which might influence the association of air monitoring results and measures of outcome. Air treatment or cooking fuel as surrogates for these indoor exposures might have been useful if they were differently distributed according to outcomes of importance. Since such differences were not found further use of these, as surrogates, was not attempted.

C. Geographic Origin

Data were collected from the U.S. census reports for each town or city for each decennial census and assigned to a subject born in that town in the given decade. Identifying most of the towns or cities was a reasonable task but for a small percentage no census information could be discovered.

A similar effort was made to identify residence from birth until adulthood (estimated end of physical growth). A review of the coded residential hisory along with the answer to the question about residence during childhood led to the judgement that these data were not reliable.

The interview schedule only asked for residential history for the period of living outside of the primary community. Adults may have answered this for their entire lives or just for their adult lives. To estimate how complete these reports were, the sum of the years in each location was subtracted from each subject's current age to confirm that the difference was close to zero. This required treating a subject's response about childhood residence as referring to the first 18 years of life. In doing this, however, more than a third of the population's residential histories summed to more than five years short of zero and less than a third had these differences equal to zero. This was taken as evidence that the residential histories, especially childhood history were incomplete.

Since use of the size of the population of the location(s) where a subject was resident during childhood required accepting this surrogate as a measure of ambient air pollution exposure during lung growth, it was already substantially removed from a true estimate of that environmental exposure. Given the discovery of incompleteness in the data, it was decided to limit this exploration to the place of birth of subjects and not take account of their location during physical growth after birth.

D. Cigarette Smoking Habit Information

There was some alteration in cigarette smoking habit during the course of the study period. This was not, however, of a magnitude sufficient to result in substantial reduction in the population size. Since it is difficult to measure the impact of change of smoking habit <u>during</u> a study it was considered preferable to limit the study to those without change. On average 84% of males did not change their smoking habit compared with 88% of females. The differences between communities was small and not significant.

E. Sample Size Estimation

Regression equations from the literature (Knudson et.al., Dockery et.al) along with some generated from this data set were explored with the objective of finding those that were most appropriate for standardizing the various lung function measurements examined. This effort concentrated on FEV_1 and FVC since these have been extensively studied, good published models exist to estimate their values and such models explain more than half the variance in these measurements.

Two sets of equations were generated from the study subjects. One used the baseline measurements of pulmonary function for adult subjects while the other set was generated using the measurements collected at the resurvey. The number of Hispanics and Blacks included in this study were too few to generate stable estimates of pulmonary function for these ethnic and racial groups. Since there are no generally accepted published equations for such groups, the evaluations reported are limited to the white study subjects.

In order to focus on the age group in which lung function is most stable, only those aged 25 through 59 at the beginning of the study were included. Data used to generate the regression equations was limited to that from subjects who were never smokers, had not changed their place of residence because of lung function problems, and did not report symptoms of bronchitis nor a history of asthma or emphysema.

Initially the FEV_1 for subjects from the three cities was examined as a function of height separately for three height groups for both males and females. The curves were generally comparable. As a result, the data from the three cities were combined to generate a single regression for each pulmonary function parameter, separately for males and females. Several alternative forms of the regression equations were developed for males and females separately, including:

1) linear in age and height
2) linear in age but quadratic in height
3) quadratic in both age and height
4) proportional regression model with FEV_1 or FVC divided by the square of height
5) same as 4) but combining data for males and females with sex as an indicator variable

In addition, two published equations were used

6) linear in age and height (Reference 15)
7) proportional regression with FEV_1 or FVC divided by the square of height for both sexes (Reference 16)

The regression equations for FVC and FEV_1 for each of these seven models are reproduced in Tables 5 and 6. In order to evaluate the equations, several comparisons were made. First, the study group was divided into subgroups by age and height. For each height and age group, the average of the actual values of lung function and the average of the predicted values based on each equation were calculated. These were then compared by examining the differences between the averages for observed and expected within each age/height cell (sample in Table 7). Each of the seven equations was also used to predict FEV_1 and FVC for specified values of age and height.

The differences in pairs of these equations were then organized by age and height groups. Table 8 presents an example of the results for FEV_1 for differences between Equation 1 and the other six equations. Since no objective criteria exist for making these comparisons, the examination of the tables was accomplished at a joint meeting of the clinicians, epidemiologists and biostatisticians. These meetings focused on the observation that each equation's estimates of age-height-sex specific values were very similar for the mid range of age and height. Each, however, was differently variable at the extremes of age and height. Since, at these extremes, no equation emerged as superior to the others the decision was made to select the equations which were simplest in form and represented the study population best. As a result the linear equations using the study population results (represented by Equation 1 above) were selected as the ones to be used for standardization.

Several reasons can be cited for this decision. The simplicity of the equations is attractive and will encourage future investigators to consider their use. Second, the differences among the equations were not sufficiently large to distinctly identify any other one as the clear equation of choice. Third, for the age and height ranges in which they were the largest number of subjects, the linear equations seemed to do as well as, or better than any of the other equations. Analogous linear equations were derived for all the remaining lung function measurements.

Table 9 includes the estimated regression coefficients for males and females separately and also for each survey (Times 1 and 2). Included also are the adjusted multiple R square for each equation and the standard errors of the coefficients for age and height. Examination of the table indicates several conclusions. First, there is no obvious difference between the time periods in terms of the coefficients or the other quantites. The equations for time 1, fitted to the full orginal sample, were then selected as the standardization equations, since data for time 2 were obtained only from those who returned for resurvey. Examination of the values of adjusted multiple R squared reveals that several of the equations are not useful as standardizations, since these values are too small. The only equations used for standardization, therefore, are the ones for FVC, FEV_1 and FEF_{25-75}.

Once these decisions were made, a variety of ways of standardizing values were applied. These standardizations were computed separately for males and females and included the following:

a. residual as value of observed minus predicted divided by age at baseline:

$$(\text{Observed}_1 - \text{Predicted}_1) / \text{Age}_1$$

b. percent predicted at baseline

$$(\text{Observed}_1 / \text{Predicted}_1) * 100$$

c. difference between measurements at Times 1 and 2 divided by the time interval:

$$(\text{Observed}_2 - \text{Observed}_1) / (\text{Time}_2 - \text{Time}_1)$$

d. difference of observed values, divided by the product of the observed baseline value and the time interval

$$(\text{Observed}_2 - \text{Observed}_1) / [\text{Observed}_1 * (\text{Time}_2 - \text{Time}_1)]$$

e. difference of observed values divided by the product of the predicted baseline value and the time interval

$$(\text{Observed}_2 - \text{Observed}_1) / [\text{Predicted}_1 * (\text{Time}_2 - \text{Time}_1)]$$

f. Difference of observed divided by predicted at Time 2 minus observed divided by predicted at Time 1:

$$(\text{Observed}_2 / \text{Predicted}_2) - (\text{Observed}_1 / \text{Predicted}_1)$$

The means and standard deviations for these parameters for smokers and never smokers by sex are displayed in Table 10.

For each of the measurements described, the sample size necessary to achieve a specified power in detecting the observed difference between the two groups (current smokers and never smokers) was calculated by the two sample "t" test. This was done for specified powers of 0.75, 0.80, 0.85, and 0.90. The power calculations approximated this by a normal test, since the sample sizes are all large enough to justify this approximation. Therefore the formula used for computing the sample size is :

$$\frac{2\ \text{sigma}^2\ (Z_{1-\text{alpha}} + Z_{1-\text{beta}})^2}{(\text{mu}_1 - \text{mu}_2)^2}$$

Where: mu_1 = mean for smokers

mu_2 = mean for nonsmokers

sigma = pooled standard deviation for the two groups

alpha = significance level

1 - beta = power

$Z_{1-\text{alpha}}$ = point to the left of which there is an area of (1-alpha) under the standard normal curve; $Z_{1-\text{beta}}$ is defined similarly.

Tables 11 and 12 show these sample sizes for males and females respectively. It is noted that the required sample sizes vary considerably for the different variables. The larger is the quantity $(\text{mu}_1 - \text{mu}_2)^2$ / sigma^2, the smaller is the required sample size. Note also that standardizations can result in either a smaller or larger sample size, depending upon the measurement being considered.

It can also be argued that the expected differences due to air pollution may be half as large as those observed between current smokers and never smokers. In that case, the sample sizes necessary are simply four times the sample sizes shown in the tables.

F. Selection of Outcome Variables

A large number of pulmonary function measurements were collected on the study subjects. The problems with plethysmography were documented in the earlier report [7]. The remaining tests derived from the forced expiratory effort and the nitrogen washout were eligible for further consideration.

At the outset it was understood that a certain amount of redundancy was inherent in these tests. To some extent, they could be considered as reflecting effects on the small or large airways or the lung parenchyma. Since, however, none uniquely measure a specific component of physiologic lung function, the overlap necessarily results in some redundancy. The use of principal components analysis was explored to determine if some appropriate combination of pulmonary function measures would provide a good summary measure of respiratory function.

A number of sets of pulmonary function variables were inspected on subsets (e.g. city, sex, age) of persons to see if there were linear functions of them which varied considerably or alternatively did not vary much over the members of the group. Both baseline pulmonary function measurements and changes in measurements over time were considered. As expected, there were such functions, roughly consistent over the groups. However, these new variables did not correlate with air pollution indices better than the single pulmonary measurements did.

A second effort was focused on the interpretation of results of a more direct examination of correlations among the following (FEV_1, FEV_1/FVC, delta N_2, V_{50}, and FEF_{25-75}). These tests were selected as the ones which are considered by respiratory physiologists as most likely to be estimating the function of relatively discrete parts of the respiratory tract. The analysis was carried out by developing a log-linear model performed on all subjects with no change in smoking history during the study interval. The model included smoking status and permitted all interactions but only two-way interactions proved informative.

The log-linear model required that each variable's range be discretized and in this case the ranges were dichotomized. Each of the pulmonary function values for each subject was classified as either "low" or "high". "Low" values were those one or more standard deviations below the standardizing equation's prediction for the individual.

The data were then classified into a multidimensional table according to each individual's measurements. The log-linear model stipulates that the logarithm of the probability that an individual falls in a given cell follows a model similar to taht of an analysis of variance. Specifically:

Logarithm

of the probability	=	grand mean
	+	main effect for each variable
	+	two-way interactions for each pair of variables
	+	three-way interactions
	+	...

Details of this model and its uses can be found in the monographs by Knoke and Burke[17] or Fienberg[18]. The analysis was performed by the program BMDP4F.

The results indicated that most of the tests had both significant partial and marginal associations (see Table 13). All the pairs of variables having significant interactions are listed in the table. For example, among the males there is a significant interaction between smoking and delta N_2, between smoking and FEF_{25-75}, etc. Of interest was the minimal association of the delta N_2 result (only associated with the FEV_1/FVC). Since these findings did not lead to a definitive conclusion they were used as background to a discussion where tests were selected based on a judgement that each one was likely to represent a distinct component of pulmonary physiologic capacity.

In essence an expert consideration of these statistical findings was undertaken with the objective of reducing the number of outcome measures of pulmonary function to those which were either not correlated, or if correlated would still permit interpretation of different associations with independent variables. The final judgement was to select FEV_1 as a measure of volume (preferable to FVC since it is timed and has a specifically defined end point), FEV_1/FVC as a measure of large airway function , and delta N_2 as a measure of small airway function.

These outcomes were then employed in multivariate modeling. The baseline observed value was standardized as a percent of predicted (% O/P) or as a residual difference from predicted (O -P), using the equations predicting the three pulmonary function measures for the three communities combined for white, aged 25-59 never smokers from Table 9.

For the change in function over time the result was calculated directly as a rate difference, subtracting the baseline from the follow-up value and dividing by the interval between the two.

These variables were treated as dependent variables in multivariate models both in their continuous form and as discrete outcomes classified as normal or abnormal. The discrete outcomes were designed to reflect possible "susceptible" or "sensitive" subpopulations (the "abnormals") to compare with those considered "non-susceptible" or "non-sensitive" (the "normals"). Such subgroups might experience different effects compared to the rest of the population which would be evident in the multivariate model.

In order to identify an appropriate cut-point for these categorizations, an arbitrary decision was made to use 1.5 standard errors below the predicted value for baseline measures of FEV_1 and the clinical criterion of 70% for the ratio FEV_1/FVC.

Since it has proven extremely difficult to identify a reliable way to examine respiratory symptom change longitudinally, such an effort was not attempted. However, symptoms and respiratory health history were used to identify another type of "susceptible" population. Two symptoms were combined. The first was a history of asthma confirmed by a physician. The second was report of 20 or more days per year when breathing sounded wheezey. Persons answering "yes" to both of these questions were collapsed into one subgroup of "susceptibles" (labeled Asthma + Wheeze).

G. Modeling of Pulmonary Function

The multivariate modeling was planned to use the dependent variables as continuous and as dichotomous outcomes. The dependent variables for linear regression on baseline values of pulmonary function were FEV_1, FEV_1 and delta N_2 each represented as observed (O), observed as percent of predicted (% O/P) and as observed - predicted (O - P). The dependent variables for change in pulmonary function were FEV_1, FEV_1/FVC and delta N_2 represented as annualized values. The independent variables to be used depended, in part, on analysis and the model.

1. <u>Never Smoking Non-commuting Females</u>

For the major linear regression modeling the focus was on estimating an effect on pulmonary function among never smoking women who did not commute. The relationship of the size of this group in relationship to the overall group of women is shown in Tables 14A-C by smoking and susceptibility group. In this case the following independent variables were used: age (continuous), height (continuous), time outdoors (continuous), community (indicator for each of the three communities), birthplace (dichotomous as Los Angels or other), size of birthplace city (continuous) and birth year (continuous). Age is measured at examination time. Since exams were at different times over a total of ten years, age and birth year give different information. All models were developed using the forward stepwise procedure BMDP2R and including those variables which met the minimum of $F \geq 2.1$ ($p \leq 0.15$).

<u>Linear Regression on Baseline Function Measures:</u> For modeling the actual value of the function test (Table 15), age and height were significant for all three variables (FEV_1, FEV_1/FVC and delta N_2. For FEV_1, the larger the population of the birthplace, the larger the measured function. Whether the birth occurred in Los Angeles or elsewhere was not important. Residence in one of the three different communities was not significant either. To the extent that size of birthplace was an indicator for an environment with more ambient air pollution, these results did not suggest individuals with better lung function were more likely to be born in "less polluted" communities. When FEV_1 was adjusted (as percent predicted or residual) no improvement in the model was noted.

For FEV_1/FVC, age and height were significant, although the age association was in a positive direction. In addition birth year, but not size of birthplace was associated with larger (better) values. Here, however, residence in Long Beach was associated with poorer function.

For delta N_2 only age and height were significant. In neither of these cases was the adjusted R^2 value at all sizeable. The adjusted R^2 takes into account the number of variables and the sample size. There is no direct relationship to significance level.

Linear Regression on Change in Function Measures: Although the overall adjusted R^2 values were small for each of the three pulmonary function parameters measuring a change over time, it was interesting to note tht accelerated decline in FEV_1 was associated with residence in Glendora and a slowed decrease in delta N_2 was associated with residence in Lancaster.

Logistic Regression on "Normal" Outcomes: When stepwise logistic regression was used to examine the probability of a "normal" outcome (i.e. a subject categorized as "non-susceptible") FEV_1 was associated positively only with time spent outdoors (Table 16). For FEV_1/FVC, using <70% as the cut-point, the same association was seen for time spent outdoors but, in addition, being born in a city of size greater than 10,000 was negatively associated (lower baseline FEV_1/FVC).

Time spent outdoors and being born outside Los Angeles were positively associated with the absence of a history/symptom complex of asthma plus current wheezing (as an indicator of "non-susceptibility"). In contrast to the linear regression, there is no measure of the explanatory power of the logistic regression currently available.

2. Non-commuting Females with Smoking History:

A similar analysis was directed at the housewives and other non-commuting females with any cigarette smoking history (current and former smokers combined). For this analysis no attempt was made to include any quantification of the smoking history in the model.

Linear Regression on Baseline Function Measures: Size of birth location was still positively associated with baseline FEV_1 (Table 17). Now, however, there was also a negative association between residence in Long Beach and both percent predicted and residual FEV_1.

For FEV_1/FVC only age and height were associated with the ratio. In contrast to the finding in non-smokers, however, the age association is negative (as expected). The only variable to enter the model for percent predicted FEV_1/FVC or residual FEV_1/FVC was residence in Glendora. This association was positive but the overall adjusted R^2 is very small.

In the case of delta N_2 there is an association of time spent outdoors with larger (poorer) values as well as a negative association (of better values) with residence in Glendora. When examining the adjusted values for delta N_2, similar results obtain with the addition of a negative association with size of birth city.

Linear Regression on Change in Function Measures: When examining change in the pulmonary function parameters over time, the same association with study community residence is seen for

FEV_1 and for delta N_2. There is, however, the additional association of an decelerated change in ratio and residence in Lancaster.

Logistic Regression on "Normal" Outcomes: The only finding worthy of mention in the logistic analysis is the identification of a negative association with residence in Long Beach and a positive association with residence in Glendora for "normal" FEV_1 (Table 18).

3. Effect of Commuting

Although the effort to associate pulmonary function with ambient air pollution required limiting the study to non-commuters, it was considered appropriate to examine the magnitude of the effect of commuting on pulmonary function. For this purpose males who commuted were examined by adding an independent variable for minutes spent commuting to the models used for non-commuting females. The results of this analysis suggested that the effect of commuting was quite small (of the order of .0005 mls/minute of commuting) in modeling baseline FEV_{1D} and -0.005 mls/minute for rate of change in FEV_1. Either air pollution exposure during commuting is not effectively measured by this surrogate, or the effect of exposure during commuting is very small.

4. Alternative Models of Community Exposure

The models above considered the three study communities separately each one being a community with a specific ambient air contaminant profile. There was variation of the six basic air contaminants over time both within a community and between the three communities. This variation in different levels of each air contaminant was difficult to model since the subjects in each of the three communities could not be distinguished from others in the same community with regard to their exposures over the five-year study interval.

Since there was no clear prior hypothesis concerning which particular combination of pollutants would most likely be more strongly associated with poor outcomes, models were generated, as above, for each of the three combinations of two communties. However, the sets of models generated for the three pairs of communities were not distinguishable. It is possible that groupings of two or more of the individual air contaminants (SO_2, Sulfates, Particulates, NO, NO_2, and Ozone) may prove of interest in future studies. In order to examine this possibility it will be necssary to have subjects who have exprienced a variety of different combinations of different levels of two or more of these contaminants.

V. CONCLUSION

These investigations provided some useful information for future study of the effects of ambient air pollution on respiratory health. Many of the significant implications of the findings have already been described and discussed in the previous report on these follow-up data, "Changes in Lung Function & Exposure to Oxidants", ARB Contract # AO-133-32. . Of importance here is a summary of the methodologic issues and the findings peculiar to this effort.

The multivariate analysis of pulmonary function on the available measures or indicators of ambient air pollution along with confounders and effect modifiers did not provide a clear model which was able to improve on the earlier stratified analysis. The failure to improve on the earlier analyses does not reflect adversely upon those analyses; it is instead primarily due to insufficient specificity and detail in the data on air pollution exposure not measured by ambient air monitoring.

It must be understood that a key feature of this analysis was the dependence on quite limited information on ambient air exposure. In the earlier stratified analysis the results suggested differences in the direction expected (poorer baseline function and accelerated decrements) in the two communities which were selected because they had higher (although different) pollutant levels than did the third.[10,11]

For this effect to be well modeled by multivariate analysis would require a good and continuous relationship between the pollution measure and the functional outcomes. If the two communities have residents with poorer function for differing reasons (even if both are related to ambient air pollution), then an attempt to include them in one model may fail.

Furthermore, the inability to account for variation in air pollution exposures due to differing types of indoor air pollution, passive cigarette smoking, activity level, effects of commuting, etc., makes the task even more difficult. Future studies will need to take advantage of more detailed attention to individual exposures within the home, the local environment and the workplace.

The hypothesis about importance of birthplace on development of pulmonary function and "susceptibility" to the effects of ambient air pollution remains an intriguing one. Unfortunately, these data were not collected specifically to address this question. As a result, the analysis was limited to the use of what is probably a rather distant surrogate of the real concern with exposure in the first year of life and during growth. For example, using population (which in many large communities in the west has continued to expand) does not account for variations in industrial exposure as "smoke stack industry" grew and then collapsed and as communities became increasingly aware of the importance of controlling industrial pollution. In addition, there is the possibility that birthplace is only important in the extremes of exposure which could not be well characterized by population alone. It would seem that this hypothesis deserves testing by a study designed specifically to address it.

The effects of ambient air exposure do not appear to be so overwhelming in the general population as to make their identification matter of fact. This led to the attempt to focus on "susceptible" subpopulations in anticipation that they would be most likely to experience adverse effects, if such effects occur. This attempt also did not succeed, but again the study design was not created to test such an hypothesis.

It is recommended that an effort be made to develop consensus criteria for the definition of different types of "susceptible" populations (e.g. asthmatics requiring medical therapy, subjects with documented hyperreactive airways, persons who develop frequent colds in seasons associated with increased ambient air pollution, etc.). Such populations could then be followed for evidence of both acute and chronic response to ambient air pollution. It is likely that such subpopulations are not such a small part of the general population as to be a poor target of research aimed at identifying population effects requiring amelioration. It is also intuitive that such populations are the ones most likely to show an effect and therefore the group deserving of priority in future investigations.

The finding which was most encouraging was that regarding sample size. It would appear that, for the major measures of pulmonary function, relatively small samples can be followed to identify levels of effect equivalent to those seen when cigarette smokers are compared to never smokers. Even if half such an effect were of interest, the numbers of subjects is not unreasonably large.

The importance of this observation is clear when one considers the problem of dropouts in any longitudinal study. As was the case here, a substantial number of persons may leave a community during a study which continues over five years. More frequent measures of function would permit use of information from the shorter followup periods for those who leave before the study's conclusion. On the other hand, a smaller group, carefully cultivated to cooperate and to provide some of the detailed information needed for refined analysis of ambient air pollution effects, could prove much more productive of the kind of information required to address the need.

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INVESTIGATIVE STAFF

Responsibility for the project was organized in three categories: a) overall direction, b) sample size and modeling, c) principal components analysis. Each area was the primary responsibility of one of the investigators but there was considerable overlap with individual investigators providing input to several areas.

David Wegman, MD, MS, was the Principal Investigator and was responsible for the overall direction of the components of the study.

Abdelmonem Afifi, PhD was responsible for designing the approach to estimating sample size and supervising the necessary data analysis. Furthermore, in cooperation with Dr. Wegman he was responsible for the design and supervision of analysis of the multivariate analysis.

Frank Massey, PhD, was responsible for the principal components analysis and participated in the discussions regarding the other analytic components.

James Sayre, Dr PH, with the assistance of Mei-Miau Wu (biostatistics doctoral candidate and computer programmer) was responsible for data management and for carrying out the data analysis.

Roger Detels, MD, MS has been the Principal Investigator for the overall CORD studies. He participated along with Donald Tashkin, MD, Professor of Medicine and Director of the UCLA Pulmonary Function Laboratory, Stanley Rokaw, MD, Clinical Professor of Medicine, Anne Coulson, Adjunct Research Epidemiologist, as part of a team regularly reviewing progress, providing input into design and analysis decisions and critiquing the work as it evolved.

LIST OF TABLES

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Table 1.

Demographic Characteristics of Study Census Tracts in Lancaster, Long Beach and Glendora*

Characteristics	Lancaster	Long Beach	Glendora
Total residents, all ages	7,069	4,992	4,573
White (non-Spanish surnamed)	6,430 (90.9%)	4,939 (98.9%)	4,281 (93.6%)
Spanish-surnamed	434 (6.1%)	0 (0.0%)	162 (3.5%)
Black	91 (1.3%)	3 (0.1%)	3 (0.1%)
Other	114 (1.6%)	50 (1.0%)	127 (2.8%)
Total 7+ years of age	6,121	4,691	4,061
Median income	$11,631	$11,474	$12,746
Number of housing unit	2,238	2,197	1,611
Proportion of homeowners	63%	64%	61%
Median home value	$18,600	$23,400	$23,850

*According to the 1970 Census

Table 2

Number, Proportion, and Characteristics of Residents Completing Baseline Lung Function Testing in Lancaster, Long Beach and Glendora

	Lancaster	Long Beach	Glendora
Households occupied	2,551	2,645	2,629
Households enumerated	2,143 (84%)	2,514 (95%)	2,596 (98%)
Residents enumerated:	5,722	5,007	4,809
Completed testing	4,509 (79%)	3,786 (76%)	3,403 (71%)
Completed questionnaire only	79 (1%)	405 (8%)	374 (8%)
Not tested	1,134 (20%)	816 (16%)	1,008 (21%)
Characteristics of residents completing testing			
White: Male	2,085 (46%)	1,668 (44%)	1,535 (45%)
Female	2,186 (48%)	1,987 (52%)	1,721 (51%)
Spanish-surnamed: Male	59 (1%)	33 (1%)	45 (1%)
Female	50 (1%)	48 (1%)	70 (2%)
Black: Male	41 (1%)	3 (<1%)	2 (<1%)
Female	46 (1%)	17 (<1%)	2 (<1%)
Other: Male	17 (<1%)	14 (<1%)	11 (<1%)
Female	25 (<1%)	16 (<1%)	11 (<1%)
TOTALS:	4,509 (100%)	3,786 (100%)	3,403 (100%)
Total Males	2,202 (49%)	1,718 (45%)	1,599 (47%)
Total Females	2,307 (51%)	2,068 (55%)	1,804 (53%)

Table 3

Number of Subjects Derived from Original Survey Available for Followup Analyses

City	Total Tested at Baseline	Adults* Tested at Baseline	Adults Retested
Lancaster			
Males	2085	973	535
Females	2186	1081	637
Long Beach			
Males	1668	746	363
Females	1987	878	444
Glendora			
Males	1535	757	467
Females	1721	870	556

* Adult = Age 25-59

Table 4A

Number of Subjects Retested According to Unchanged Smoking Habit and Susceptibility Group *

LANCASTER

	CURRENT SMOKER		NEVER SMOKER		FORMER SMOKER	
	Male	Female	Male	Female	Male	Female
Total**	134	157	165	315	144	79
Baseline FEV_1						
Normal	105	115	147	273	128	68
Abnormal	25	36	13	32	9	8
Baseline FEV_1/FVC						
Normal	107	120	142	280	127	69
Abnormal	23	31	17	25	10	7
History of Asthma or Wheeze						
Normal	133	152	162	310	143	78
Abnormal	1	5	3	5	1	1

* See text for definition
** Due to missing values susceptible & nonsusceptible is not always equal to the total

Table 4B

Number of Subjects Retested According to Unchanged Smoking Habit and Susceptibility Group *

LONG BEACH

	CURRENT SMOKER		NEVER SMOKER		FORMER SMOKER	
	Male	Female	Male	Female	Male	Female
Total**	76	96	131	236	92	60
Baseline FEV_1						
Normal	60	68	116	203	70	51
Abnormal	11	24	10	23	17	6
Baseline FEV_1/FVC						
Normal	57	79	118	205	74	49
Abnormal	16	13	8	21	13	8
History of Asthma or Wheeze						
Normal	75	94	130	234	91	58
Abnormal	1	2	1	2	1	2

* See text for definition

** Due to missing values susceptible & nonsusceptible is not always equal to the total

Table 4C

Number of Subjects Retested According to Unchanged Smoking Habit and Susceptibility Group *

GLENDORA

	CURRENT SMOKER		NEVER SMOKER		FORMER SMOKER	
	Male	Female	Male	Female	Male	Female
Total**	102	102	163	311	134	84
Baseline FEV_1						
Normal	79	77	155	278	124	70
Abnormal	23	25	8	33	10	14
Baseline FEV_1/FVC						
Normal	88	85	144	295	123	79
Abnormal	14	17	19	16	11	5
History of Asthma or Wheeze						
Normal	101	98	161	306	129	81
Abnormal	1	4	2	5	5	3

* See text for definition

** Due to missing values susceptible & nonsusceptible is not always equal to the total

Table 5A

Alternative Equations for Predicting
FVC by Age and Height
White Male Never Smokers Ages 25 - 59

Forced Vital Capacity

1. $FVC = -7.4084 - 0.028 * Age + 0.195 * Ht$

2. $FVC = 44.9300 - 0.029 * Age - 1.306 * Ht + 0.0108 * Ht^2$

3. $FVC = 45.5996 - 0.411 * Age - 1.319 * Ht + 0.0001 * Age^2 + 0.011 * Ht^2$

4. $FVC = Ht^2 * [0.0013 - (0.51 * Age + 0.0014 * Age^2) * 10^{-5}]$

5. $FVC = Ht^2 * [0.0011 - 0.0002 * Sex * (0.22 * Age - 0.0095 * Age^2) * 10^{-5}]$

6. $FVC = -5.459 - 0.029 * Age + 0.065 * Ht * 2.54$

7. $FVC = Ht^2 * [0.0012 - 0.00019 * Sex * (0.87 * Age + 0.65 * Age^2) * 10^{-7}]$

Standard Errors of the Estimate for Coefficients for FVC

	Const.	Age	Height	Age^2	$Height^2$	Sex	r^2
1.	1.0115	0.004	0.014	-	-	-	0.4469
2.	17.2186	0.003	0.494	-	0.00035	-	0.4621
3.	17.3334	0.032	0.496	0.00004	0.0036	-	0.4608
4.	0.0001	0.67	-	0.008	-	-	0.1739
5.	0.0001	0.34	-	0.0041	-	0.000008	0.4812

Table 5B

Alternative Equations for Predicting
FEV_1 by Age and Height
White Male Never Smokers Ages 25 - 59

Forced Expiratory Volume in One Second

1. $FEV_1 = -4.1391 - 0.026 * Age + 0.135 * Ht$

2. $FEV_1 = 28.4249 - 0.264 * Age - 0.8029 * Ht + 0.0067 * Ht^2$

3. $FEV_1 = 29.0178 - 0.037 * Age - 0.814 * Ht + 0.00013 * Age^2 + 0.0068 * Ht^2$

4. $FEV_1 = Ht^2 * [0.00109 - (0.61 * Age + 0.00067 * Age^2) * 10^{-5}]$

5. $FEV_1 = Ht^2 * [0.0010 - 0.00015 * Sex * (0.08 * Age - 0.0056 * Age^2) * 10^{-5}]$

6. $FEV_1 = -4.203 - 0.027 * Age + 0.052 * Ht * 2.54$

7. $FEV_1 = Ht^2 * [0.00099 - 0.00013 * Sex * (0.262 * Age + 0.004 * Age^2) * 10^{-5}]$

Standard Errors of the Estimate for Coefficients for FEV_1

	Const.	Age	Height	Age^2	$Height^2$	Sex	r^2
1.	0.8084	0.003	0.011	-	-	-	0.4204
2.	13.8637	0.003	0.398	-	0.0029	-	0.4309
3.	13.9555	0.026	0.400	0.00031	0.0029	-	0.4336
4.	0.0011	0.53	-	0.00634	-	-	0.2056
5.	0.0001	0.28	-	0.0033	-	0.000006	0.4812

Table 6A

Alternative Equations for Predicting
FVC by Age and Height
White Female Never Smokers Ages 25 - 59

Forced Vital Capacity

1. $FVC = -2.6681 - 0.021 * Age + 0.109 * Ht$

2. $FVC = -3.0444 - 0.022 * Age + 0.119 * Ht - 0.00007 * Ht^2$

3. $FVC = -3.0537 + 0.024 * Age + 0.093 * Ht + 0.00055 * Age^2 + 0.00013 * Ht^2$

4. $FVC = Ht^2 * [0.0008 + (0.62 * Age - 0.014 * Age^2) * 10^{-5}]$

5. $FVC = Ht^2 * [0.0011 - 0.0002 * Sex * (0.22 * Age - 0.0095 * Age^2) * 10^{-5}]$

6. $FVC = -1.744 - 0.022 * Age + 0.037 * Ht * 2.54$

7. $FVC = Ht^2 * [0.0012 - 0.00019 * Sex * (0.87 * Age + 0.65 * Age^2) * 10^{-7}]$

Standard Errors of the Estimate for Coefficients for FVC

	Const.	Age	Height	Age^2	$Height^2$	Sex	r^2
1.	0.5205	0.002	0.008	-	-	-	0.3800
2.	9.0836	0.002	0.283	-	0.00221	-	0.3889
3.	9.0339	0.016	0.282	0.00019	0.0022	-	0.3956
4.	0.0001	0.39	-	0.005	-	-	0.2222
5.	0.0001	0.34	-	0.0041	-	0.000008	0.4812

Table 6B

Alternative Equations for Predicting
FEV_1 by Age and Height
White Female Never Smokers Ages 25 - 59

Forced Expiratory Volume in One Second

1. $FEV_1 = -1.1210 - 0.022 * Age + 0.077 * Ht$

2. $FEV_1 = -5.6180 - 0.022 * Age + 0.2154 * Ht - 0.0011 * Ht^2$

3. $FEV_1 = -5.6242 + 0.008 * Age + 0.198 * Ht - 0.00037 * Age^2 + 0.0009 * Ht^2$

4. $FEV_1 = Ht^2 * [0.0008 + (0.22 * Age - 0.0093 * Age^2) * 10^{-5}]$

5. $FEV_1 = Ht^2 * [0.0010 - 0.00015 * Sex * (0.08 * Age - 0.0056 * Age^2) * 10^{-5}]$

6. $FEV_1 = -0.794 - 0.021 * Age + 0.027 * Ht * 2.54$

7. $FEV_1 = Ht^2 * [0.00099 - 0.00013 * Sex * (0.262 * Age + 0.004 * Age^2) * 10^{-5}]$

Standard Errors of the Estimate for Coefficients for FEV_1

	Const.	Age	Height	Age^2	$Height^2$	Sex	r^2
1.	0.4217	0.001	0.006	-	-	-	0.4143
2.	7.3998	0.001	0.2309	-	0.0018	-	0.4218
3.	7.3741	0.013	0.230	0.00016	0.0018	-	0.4258
4.	0.0011	0.32	-	0.0038	-	-	0.2979
5.	0.0001	0.28	-	0.0033	-	0.000006	0.4812

Table 7

Mean Difference Between Actual and Predicted FEV_1 (Time 1) for Age-Height Subgroups* (Females)

HT=56-60	AND AGE=	25-27	28-32	33-37	38-42	43-47	48-52	53-57	58-59
	N=	8	8	6	2	4	4	5	2
	1	-0.07	-0.08	-0.03	-0.03	0.10	-0.27	-0.04	0.12
	2	0.08	0.06	0.12	0.12	0.24	-0.12	0.11	0.27
	3	-0.00	-0.06	-0.04	-0.05	0.08	-0.25	0.01	0.21
	4	-0.01	-0.08	-0.07	-0.09	0.02	-0.33	-0.09	0.10
	5	0.01	-0.05	-0.02	-0.04	0.07	-0.30	-0.06	0.11
	6	0.05	0.04	0.09	0.08	0.20	-0.18	0.05	0.21
	7	0.10	0.06	0.10	0.09	0.21	-0.15	0.09	0.26
HT=61-62	AND AGE=	25-27	28-32	33-37	38-42	43-47	48-52	53-57	58-59
	N=	14	27	20	17	17	17	35	8
	1	0.02	-0.07	-0.10	0.14	-0.05	0.08	0.05	-0.25
	2	0.14	0.06	0.03	0.27	0.08	0.22	0.19	-0.11
	3	0.05	-0.07	-0.13	0.10	-0.08	0.07	0.08	-0.16
	4	0.02	-0.10	-0.17	0.05	-0.15	0.00	0.00	-0.26
	5	0.05	-0.07	-0.12	0.10	-0.10	0.04	0.03	-0.25
	6	0.15	0.06	0.03	0.26	0.06	0.19	0.16	-0.14
	7	0.15	0.05	0.01	0.25	0.06	0.20	0.19	-0.09
HT=63-65	AND AGE=	25-27	28-32	33-37	38-42	43-47	48-52	53-57	58-59
	N=	44	54	54	41	49	35	49	16
	1	-0.06	0.03	0.00	0.14	0.05	-0.02	-0.04	-0.06
	2	0.07	0.16	0.13	0.27	0.19	0.11	0.10	0.08
	3	-0.03	0.02	-0.04	0.09	0.01	-0.04	-0.01	0.02
	4	-0.11	-0.07	-0.12	0.01	-0.07	-0.12	-0.09	-0.06
	5	-0.09	-0.03	-0.07	0.06	-0.02	-0.08	-0.07	-0.06
	6	0.10	0.18	0.15	0.28	0.19	0.10	0.09	0.06
	7	0.03	0.10	0.08	0.22	0.15	0.09	0.11	0.11
HT=66-68	AND AGE=	25-27	28-32	33-37	38-42	43-47	48-52	53-57	58-59
	N=	22	30	11	22	18	15	19	3
	1	-0.11	0.07	0.08	0.02	-0.01	-0.16	-0.06	0.00
	2	0.03	0.21	0.22	0.16	0.13	-0.01	0.09	0.16
	3	-0.08	0.07	0.04	-0.03	-0.06	-0.17	-0.03	0.07
	4	-0.23	-0.08	-0.10	-0.17	-0.18	-0.28	-0.13	-0.02
	5	-0.21	-0.04	-0.05	-0.11	-0.12	-0.23	-0.10	-0.01
	6	0.07	0.25	0.25	0.18	0.14	-0.00	0.08	0.15
	7	-0.09	0.10	0.11	0.06	0.06	-0.05	0.09	0.18
HT=69-73	AND AGE=	25-27	28-32	33-37	38-42	43-47	48-52	53-57	58-59
	N=	3	5	2	4	1	4	1	0
	1	0.04	0.09	0.11	0.13	0.22	-0.27	-0.13	0.00
	2	0.21	0.27	0.28	0.31	0.42	-0.09	0.04	0.00
	3	0.08	0.11	0.08	0.10	0.21	-0.27	-0.11	0.00
	4	-0.17	-0.16	-0.15	-0.12	-0.03	-0.46	-0.26	0.00
	5	-0.14	-0.12	-0.09	-0.06	0.03	-0.40	-0.22	0.00
	6	0.24	0.29	0.30	0.32	0.41	-0.09	0.03	0.00
	7	-0.00	0.03	0.09	0.13	0.24	-0.20	-0.02	0.00

N = 1-7 refers to the numbers of the equations from Table 6

Table 8
Comparisons of Equation Selected for Standardizing FEV_1 with Alternatives: Paired differences in Predicted FEV_1 for Values of Age and Height in Females

		AGE= 25.	30.	35.	40.	45.	50.	55.	59.
EQ1-EQ2	HT= 53.	0.24	0.24	0.24	0.24	0.24	0.25	0.25	0.25
	58.	0.15	0.16	0.16	0.16	0.16	0.16	0.16	0.16
	63.	0.13	0.13	0.13	0.13	0.13	0.13	0.14	0.14
	68.	0.15	0.15	0.16	0.16	0.16	0.16	0.16	0.16
	73.	0.23	0.24	0.24	0.24	0.24	0.24	0.24	0.24
	78.	0.37	0.37	0.37	0.38	0.38	0.38	0.38	0.38
EQ1-EQ3	AGE=	25.	30.	35.	40.	45.	50.	55.	59.
	HT= 53.	0.18	0.13	0.10	0.09	0.09	0.12	0.16	0.21
	58.	0.09	0.04	0.01	-0.00	0.00	0.03	0.07	0.12
	63.	0.04	-0.00	-0.04	-0.05	-0.04	-0.01	0.03	0.08
	68.	0.05	-0.00	-0.03	-0.04	-0.04	-0.01	0.03	0.08
	73.	0.10	0.05	0.02	0.01	0.01	0.04	0.08	0.13
	78.	0.19	0.15	0.12	0.10	0.11	0.14	0.18	0.23
EQ1-EQ4	AGE=	25.	30.	35.	40.	45.	50.	55.	59.
	HT= 53.	0.15	0.08	0.02	-0.02	-0.05	-0.07	-0.07	-0.07
	58.	0.09	0.03	-0.02	-0.05	-0.06	-0.06	-0.05	-0.02
	63.	-0.01	-0.06	-0.10	-0.11	-0.11	-0.09	-0.05	-0.00
	68.	-0.15	-0.19	-0.21	-0.21	-0.19	-0.15	-0.09	-0.02
	73.	-0.33	-0.36	-0.37	-0.35	-0.31	-0.24	-0.15	-0.06
	78.	-0.55	-0.57	-0.56	-0.53	-0.46	-0.37	-0.25	-0.14
EQ1-EQ5	AGE=	25.	30.	35.	40.	45.	50.	55.	59.
	HT= 53.	0.16	0.11	0.06	0.02	-0.02	-0.04	-0.06	-0.06
	58.	0.11	0.06	0.02	-0.00	-0.02	-0.03	-0.03	-0.02
	63.	0.01	-0.02	-0.05	-0.06	-0.06	-0.05	-0.03	0.00
	68.	-0.13	-0.15	-0.16	-0.15	-0.13	-0.10	-0.06	-0.01
	73.	-0.30	-0.31	-0.30	-0.28	-0.24	-0.19	-0.12	-0.06
	78.	-0.52	-0.51	-0.49	-0.44	-0.38	-0.31	-0.22	-0.13
EQ1-EQ6	AGE=	25.	30.	35.	40.	45.	50.	55.	59.
	HT= 53.	0.07	0.07	0.06	0.05	0.05	0.04	0.04	0.03
	58.	0.11	0.11	0.10	0.09	0.09	0.08	0.08	0.07
	63.	0.15	0.15	0.14	0.13	0.13	0.12	0.12	0.11
	68.	0.19	0.19	0.18	0.17	0.17	0.16	0.16	0.15
	73.	0.23	0.23	0.22	0.21	0.21	0.20	0.20	0.19
	78.	0.27	0.27	0.26	0.25	0.25	0.24	0.24	0.23
EQ1-EQ7	AGE=	25.	30.	35.	40.	45.	50.	55.	59.
	HT= 53.	0.24	0.19	0.18	0.12	0.10	0.08	0.06	0.06
	58.	0.19	0.16	0.14	0.13	0.12	0.11	0.12	0.13
	63.	0.11	0.10	0.09	0.09	0.10	0.12	0.14	0.17
	68.	-0.00	-0.00	0.01	0.03	0.05	0.09	0.14	0.18
	73.	-0.18	-0.14	-0.11	-0.08	-0.03	0.03	0.11	0.17
	78.	-0.36	-0.32	-0.27	-0.21	-0.14	-0.05	0.04	0.13

Footnote: EQ1 - EQ7 refers to equations 1 - 7 for FEV_1 from Table 6

Table 9

Regression of Lung Function Test Measurements on Age and Height with Glendora, Lancaster and Long Beach Combined

	Estimated Regression Coefficient Intercept	Age	Height	S.E. Age	S.E. Height	Adjusted R^2
MALES						
Time 1						
FVC	-7.408	-.028	.195	.004	.014	.447
FEV_1	-4.139	-.026	.134	.003	.011	.420
$FEV_1/FVC\%$	119.942	-.055	-.500	.029	.144	.053
$\dot{V}_{50}$	.705	-.025	.085	.008	.031	.048
$\dot{V}_{MAX}$	-1.414	-.032	.205	.012	.048	.072
FEF_{25-75}	1.431	-.029	.062	.006	.023	.094
ΔN_2	.253	.009	-.001	.003	.010	.031
Time 2						
FVC	-6.472	-.027	.179	.004	.014	.446
FEV_1	-3.265	-.026	.120	.003	.012	.412
$FEV_1/FVC\%$	122.161	-.091	-.514	.028	.019	.082
$\dot{V}_{50}$	1.087	-.026	.072	.007	.027	.069
$\dot{V}_{MAX}$	-.622	-.038	.169	.009	.035	.138
FEF_{25-75}	1.984	-.033	.052	.006	.022	.122
ΔN_2	-.575	.009	.012	.002	.009	.036
FEMALES						
Time 1						
FVC	-2.668	-.021	.109	.002	.008	.380
FEV_1	-1.121	-.022	.077	.001	.006	.414
$FEV_1/FVC\%$	114.934	-.122	-.394	.024	.110	.052
$\dot{V}_{50}$	3.847	-.023	.020	004	.019	.049
$\dot{V}_{MAX}$	3.206	-.032	.089	.006	.027	.064
FEF_{25-75}	2.577	-.032	.034	.003	.016	.141
ΔN_2	.713	.014	-.009	.002	.011	.060
Time 2						
FVC	-2.322	-.025	.103	.002	.008	.440
FEV_1	-1.434	-.024	.081	.001	.007	.488
$FEV_1/F_VC\%$	103.140	-.123	-.220	.022	.104	.054
$\dot{V}_{50}$	.126	-.028	.074	.004	.017	.130
$\dot{V}_{MAX}$	-.804	-.038	.138	.005	.021	.202
FEF_{25-75}	.694	-.034	.059	.003	.014	.221
ΔN_2	-.137	.010	.002	.003	.013	.092

Table 10
Statistical Values for FEV_1 and Related Measures*
By Smoking Habit

	MALES n	MALES Mean	MALES S. D.	FEMALES n	FEMALES Mean	FEMALES S. D.
Observed (01)						
Smokers	233	3.775	0.751	243	2.686	0.506
Never Smokers	352	4.150	0.694	649	2.879	0.472
$\frac{01-P1}{Age1}$						
Smokers	233	-0.008	0.016	242	-0.004	0.011
Never Smokers	351	0.000	0.015	648	0.000	0.010
01/ P1 * 100						
Smokers	233	91.533	14.303	242	93.559	13.835
Never Smokers	351	100.146	12.435	648	100.070	12.528
$\frac{02-01}{T2-T1}$						
Smokers	216	-0.068	0.061	230	-0.049	0.039
Never Smokers	344	-0.054	0.050	634	-0.044	0.040
$\frac{02-01}{01(T2-T1)}$						
Smokers	216	-1.846	1.705	230	-1.906	1.619
Never Smokers	344	-1.297	1.237	634	-1.528	1.380
$\frac{02-01}{P1(T2-T1)}$						
Smokers	216	-1.708	1.574	229	-1.769	1.326
Never Smokers	343	-1.327	1.229	633	-1.562	1.424
$\frac{02}{P2} - \frac{01}{P1}$						
Smokers	232	-6.229	9.632	242	-6.405	7.871
Never Smokers	351	-3.738	7.189	647	-4.864	8.250

* For precise definitions of variables see pages 42-43.

Table 11
Sample Size Required to Detect a Difference as Big As that Between Current and Never Smokers (Males)

	POWER .75	.80	.85	.90
FEV_1				
01	40	46	53	63
(01-P1)/Age1	33	38	44	53
01/P1%	26	30	34	41
(02-01)/ Time	153	176	205	244
(02-01)/(01*Time) %	74	85	99	118
(02-01)/(P1*Time) %	140	161	187	223
(02/P2-01/P1) %	118	136	158	188
FVC				
01	64	74	86	102
(01-P1)/Age1	53	61	71	85
01/P1 %	45	52	60	72
(02-01)/Time	908	1045	1214	1447
(02-01)/(01*Time) %	362	416	483	576
(02-01)/(P1*Time) %	691	795	923	1101
(02/P2-01/P1) %	445	511	594	708
FEF_{25-75}				
01	51	58	68	81
(01-P1)/Age1	64	73	85	102
01/P1 %	45	51	60	71
(02-01)/Time	155	178	207	246
(02-01)/(01*Time) %	60	69	80	95
(02-01)/(P1*Time) %	156	179	208	248
(02/P2-01/P1) %	156	180	209	249
FEV_1/FVC				
01	94	108	125	149
(02-01)/Time	143	164	190	227
(02-01)/(01*Time) %	135	155	180	214
ΔN_2				
01	67	77	90	107
(02-01)/Time	182	210	243	290
(02-01)/(01*Time) %	1334	1534	1783	2125
$\dot{V}_{50}$				
01	113	130	151	180
(02-01)/Time	133	153	178	212
(02-01)/(01*Time) %	64	74	86	102
$\dot{V}_{MAX}$				
01	151	174	202	241
(02-01)/Time	779	896	1041	1241
(02-01)/(01*Time) %	214	246	286	341

Table 12

Sample Size Required to Detect a Difference as Big As that Between Current and Never Smokers (Females)

	POWER .75	.80	.85	.90
FEV_1				
01	68	78	90	107
(01-P1)/Age1	68	79	91	109
01/P1%	43	49	57	68
(02-01)/ Time	558	642	746	889
(02-01)/(01*Time) %	158	182	211	252
(02-01)/(P1*Time) %	488	561	652	777
(02/P2-01/P1) %	302	347	403	480
FVC				
01	214	246	285	340
(01-P1)/Age1	258	296	344	410
01/P1 %	142	163	189	226
(02-01)/Time	675	776	902	1075
(02-01)/(01*Time) %	359	412	479	571
(02-01)/(P1*Time) %	684	787	914	1089
(02/P2-01/P1) %	610	701	815	971
FEF_{25-75}				
01	47	54	63	75
(01-P1)/Age1	63	73	85	101
01/P1 %	43	49	57	68
(02-01)/Time	32507	37388	43448	51787
(02-01)/(01*Time) %	299	344	400	477
(02-01)/(P1*Time) %	6300	7246	8421	10037
(02/P2-01/P1) %	1377	1583	1840	2193
FEV_1/FVC				
01	58	66	77	92
(02-01)/Time	2173	2499	2904	3461
(02-01)/(01*Time) %	1342	1543	1793	2138
ΔN_2				
01	77	88	102	122
(02-01)/Time	78	90	104	124
(02-01)/(01*Time) %	769	885	1028	1226
$\dot{V}_{50}$				
01	67	77	89	106
(02-01)/Time	16254	18695	21725	25894
(02-01)/(01*Time) %	255	294	341	407
$\dot{V}_{MAX}$				
01	107	123	143	170
(02-01)/Time	12232	14068	16349	19486
(02-01)/(01*Time) %	1090	1253	1456	1735

Table 13

Table 13

Significant Variable Pairs for Smoking
and Selected Pulmonary Function Measures

Two Way Association	Partial Association D.F.	Partial Association Chi^2	Partial Association Prob.	Marginal Association D.F.	Marginal Association Chi^2	Marginal Association Prob.
Males						
Smoking/delta N_2	2	17.65	0.000	2	25.64	0.000
Smoking/ FEF_{25-75}	2	8.37	0.015	2	35.81	0.000
FEV_1/FVC/ $\dot{V}_{50}$	1	12.48	0.000	1	243.00	0.000
FEV_1/FVC/FEF_{25-75}	1	60.55	0.000	1	280.89	0.000
FEV_1/FVC/FEV_1	1	12.17	0.001	1	69.68	0.000
delta N_2/FEV_1	1	10.81	0.001	1	32.10	0.000
$\dot{V}_{50}$/FEF_{25-75}	1	127.29	0.000	1	496.78	0.000
V_{50}/FEV_1	1	10.54	0.001	1	213.63	0.000
FEF_{25-75}/FEV_1	1	46.58	0.000	1	243.19	0.000
Females						
Smoking/delta N_2	2	19.19	0.000	2	30.13	0.000
Smoking/ FEF_{25-75}	2	6.53	0.038	2	40.93	0.000
FEV_1FVC/ $\dot{V}_{50}$	1	30.18	0.000	1	304.05	0.000
FEV_1/FVC/FEF_{25-75}	1	91.58	0.000	1	359.17	0.000
FEV_1/FVC/FEV_1	1	21.53	0.000	1	77.43	0.000
delta N_2/FEV_1	1	12.81	0.000	1	37.27	0.000
$\dot{V}_{50}$/FEF_{25-75}	1	89.74	0.000	1	489.22	0.000
$\dot{V}_{50}$/FEV_1	1	30.83	0.000	1	221.21	0.000
FEF_{25-75}/FEV_1	1	50.21	0.000	1	235.75	0.000

Table 14A

Number of Female Subjects Retested According to Commuting
Unchanged Smoking Habit and Susceptibility Group *

LANCASTER

	CURRENT SMOKER		NEVER SMOKER		FORMER SMOKER	
	Commute	Noncom.	Commute	Noncom.	Commute	Noncom.
Total**	123	58	231	112	75	35
Baseline FEV_1						
Normal	92	42	204	96	63	34
Abnormal	26	15	19	14	9	1
Baseline FEV_1/FVC						
Normal	95	44	206	99	62	33
Abnormal	22	13	15	11	6	2
History of Asthma or Wheeze						
Normal	106	47	215	104	72	34
Abnormal	18	11	16	8	4	2

* See text for definition
** Due to missing values susceptible & nonsusceptible is not always equal to the total

Table 14B

Number of Female Subjects Retested According to Commuting
Unchanged Smoking Habit and Susceptibility Group *

LONG BEACH

	CURRENT SMOKER		NEVER SMOKER		FORMER SMOKER	
	Commute	Noncom.	Commute	Noncom.	Commute	Noncom.
Total**	89	29	176	74	53	19
Baseline FEV_1						
Normal	66	19	153	63	48	15
Abnormal	19	10	15	9	3	3
Baseline FEV_1/FVC						
Normal	73	24	152	63	44	15
Abnormal	9	5	13	9	5	3
History of Asthma or Wheeze						
Normal	71	26	169	71	51	19
Abnormal	18	3	8	3	4	1

* See text for definition
** Due to missing values susceptible & nonsusceptible is not always equal to the total

Table 14C

Number of Female Subjects Retested According to Commuting Unchanged Smoking Habit and Susceptibility Group *

GLENDORA

	CURRENT SMOKER		NEVER SMOKER		FORMER SMOKER	
	Commute	Noncom.	Commute	Noncom.	Commute	Noncom.
Total**	106	26	265	65	71	3
Baseline FEV_1						
Normal	80	20	235	60	58	21
Abnormal	26	6	30	5	13	2
Baseline FEV_1/FVC						
Normal	91	19	249	62	66	22
Abnormal	14	5	15	2	4	1
History of Asthma or Wheeze						
Normal	84	22	237	59	63	20
Abnormal	22	4	28	6	8	3

* See text for definition
** Due to missing values susceptible & nonsusceptible is not always equal to the total

Table 15

Stepwise Multiple Linear Regression
Women, Never Smoked, Don't Commute

Outcome	Const.	Age	Height	Residence G	Residence LN	Residence LB	Size of Birth City *	Birth Year	Adj. R^2
FEV_1									
01	-1.098	-.022	.075	–	–	–	0.72	–	0.355
01 - P1	-.058	–	–	–	–	–	0.71	–	0.009
01/P1	97.930	–	–	–	–	–	27	–	0.012
FEV_1/FVC%									
01	95.088	.067	-.316	–	–	-1.31	–	.141	0.059
01 - P1	–	–	–	–	–	–	–	–	
01/P1	–	–	–	–	–	–	–	–	
ΔN_2									
01	.201	.016	-.001	–	–	–	–	–	0.058
01 - P1	–	–	–	–	–	–	–	–	
01/P1	–	–	–	–	–	–	–	–	
FEV_1/Yr%	-4.545	–	–	-1.08	–	–	–	–	0.008
FEV_1/FVC/Yr	37.521	–	–	–	–	–	–	-1.05	0.010
ΔN_2/Yr	5.616	–	–	–	-4.643	–	–	–	0.032

Time Outdoors and Birthplace (LA or other) did not enter any model.
* The coefficient is the displayed value divided by 10^7

Table 16

Stepwise Logistic Regression
Women, Never Smoked, Don't Commute

Outcome*	Intercept	Age	Time Outdoors	Size of Birth Place**	Birth City L.A.	Birth City Elsewhere
FEV_1	1.038	-	.312	-	-	-
FEV_1/FVC%	.205	.042	.540	-	-1.40	-.440
ASTHMA + WHEEZE	-.165	-	.500	1.96	-	-

Height, Los Angeles community (Glendora, Long Beach, Lancaster), and Birth Year did not enter any model

* In each case the model predicts the probability that the outcome is "abnormal". See text for definitions of abnormal.

Table 17

Stepwise Multiple Linear Regression
Women, Current/Former Smokers, Don't Commute

Outcome	Const.	Age	Height	Time Outdoors	G	Residence LN	LB	Birth Place*	Size of Birth City**	Birth Year	Adj. R^2 t
FEV_1											
01	-2.956	-.027	.105	-	-	-	-	-	.18		.405
01 - P1	- .213	-	-	-	-	-	-.109	-	.17		.047
0 / P %	91.979	-	-	-	-	-	-4.32	-	.06		.050
FEV_1/FVC %											
01											
01 - P1	71.763	-.148	.241	-	-	-	-	-	-		.049
01/P1%	-4.298	-	-	-	1.97	-	-	-	-		.010
	94.914	-	-	-	2.34	-	-	-	-		.010
ΔN_2											
01	-.916	.028	.007	.088	-.289	-	-	-	-		.121
01 - P1	.124	-	-	.069	-.230	-	-	-	-.21		.044
01/P1%	109.347	-	-	9.10	-	-	-	-	-32.8		.037
FEV_1/Yr	-6.102	-	-	-	-1.34	-	-	-	-	.058	.037
FEV_1/FVC/Yr	80.361	-	-	-		47.4	-	-82.5	-1.10	.087	.067
ΔN_2/Yr	24.748	-	-	-		-11.3	-	-	-	-.315	.062

* 0 = Los Angeles 1 = Elsewhere
** The coefficient is the displayed value divided by 10^6

Table 18

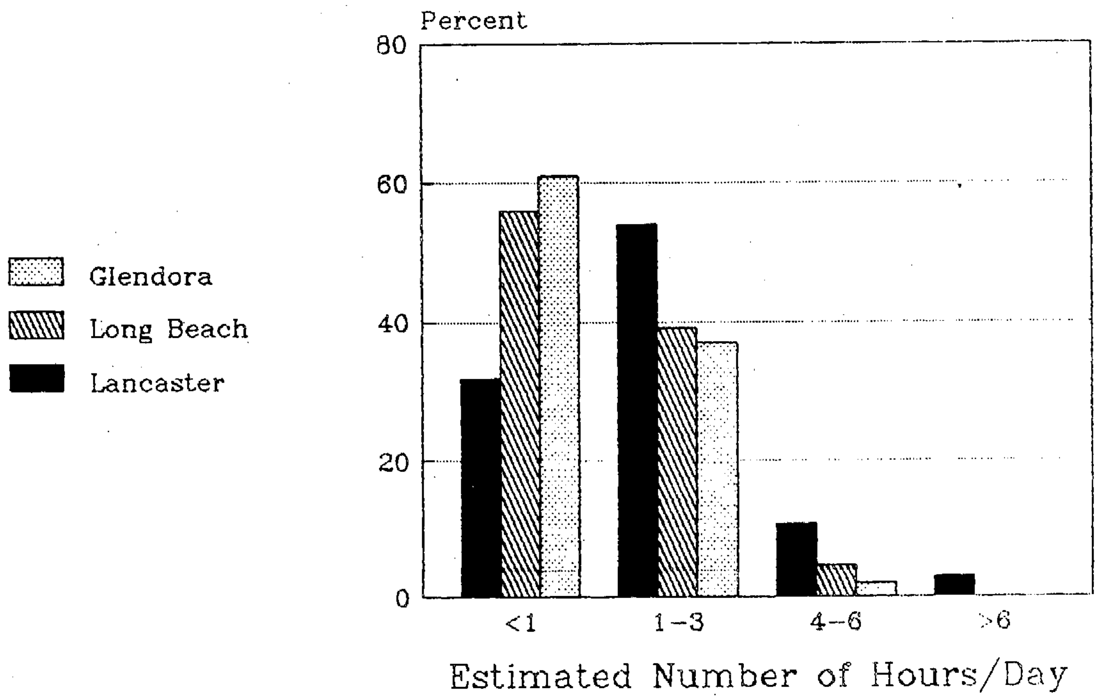
Stepwise Logistic Regression
Women, Current/Former Smokers, Don't Commute

Outcome*	Intercept	Height	Residence L.Beach	Residence Glend.	Birth Place	Birth Year**
FEV_1	-8.438	.157	-.860	.131	-	-1.14
$FEV_1/FVC\%$	-8.214	.159	-	-	-	-
ASTHMA + WHEEZE	-19.602	.315	-	-	1.95	-

Age, Size of Birth City and Time Outdoors did not enter any model.
* In each case the model predicts probability that the outcome is "abnormal". See text for definitions of abnormal.
** <1950 = 0, ≥1950 = 1

LIST OF FIGURES

Weekday Hours Outdoors
Females Employed Full Time



Weekday Hours Outdoors
Males Employed Full Time

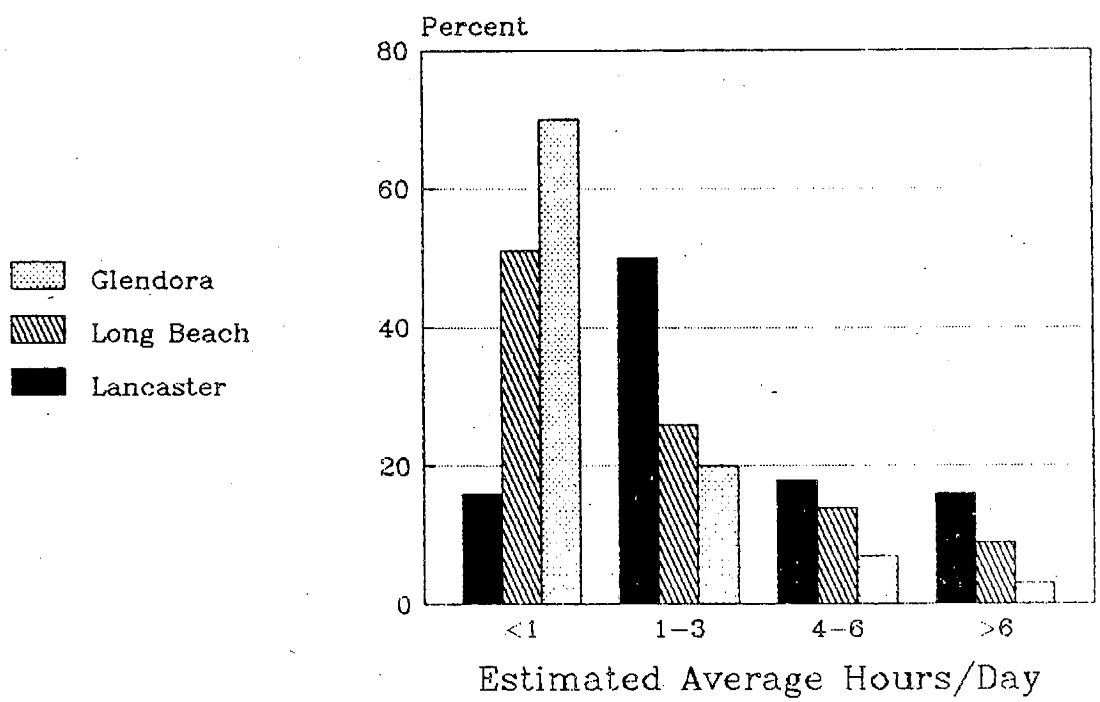
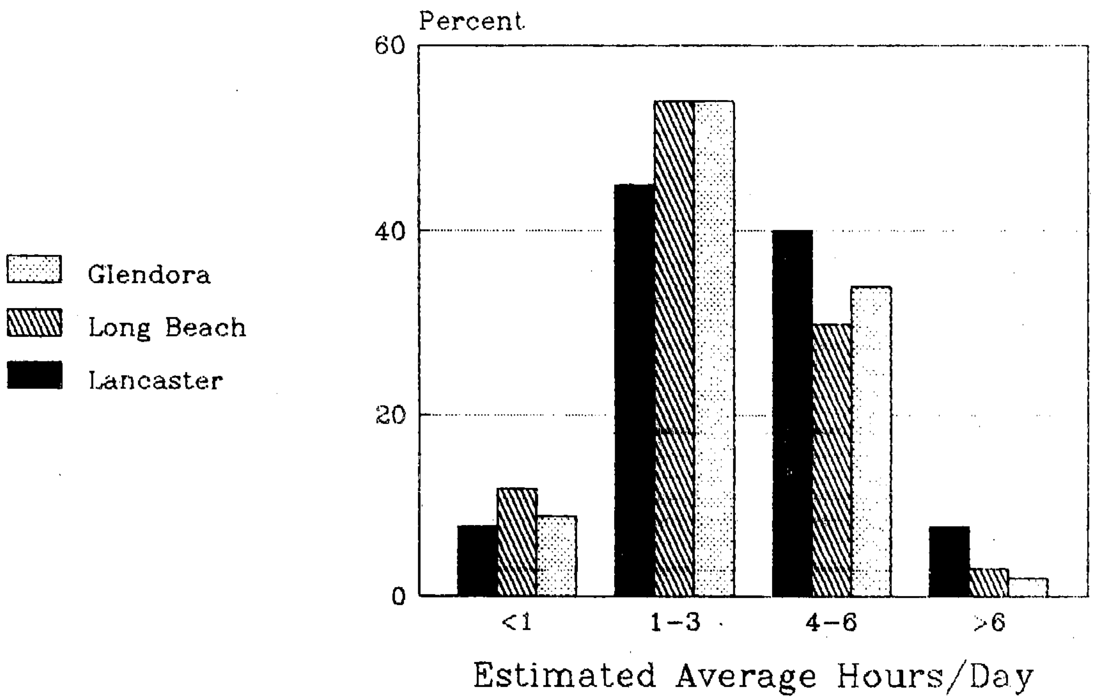


Figure 1a

Weekend Hours Outdoors
Females Employed Full Time



Weekend Hours Outdoors
Males Employed Full Time

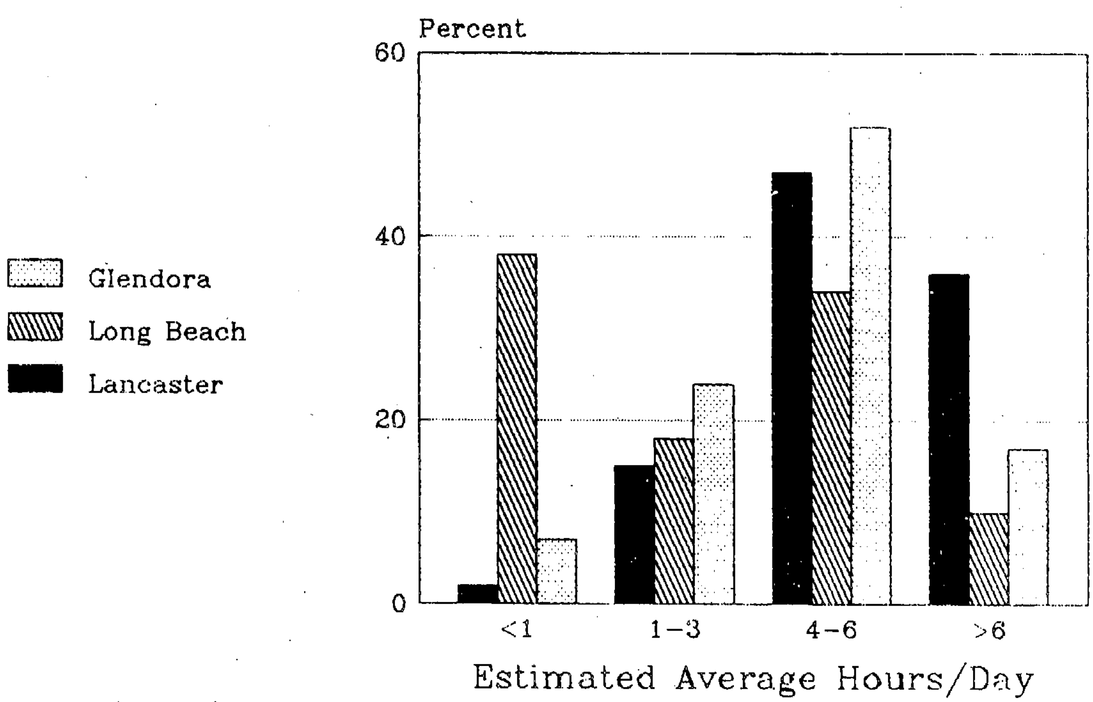
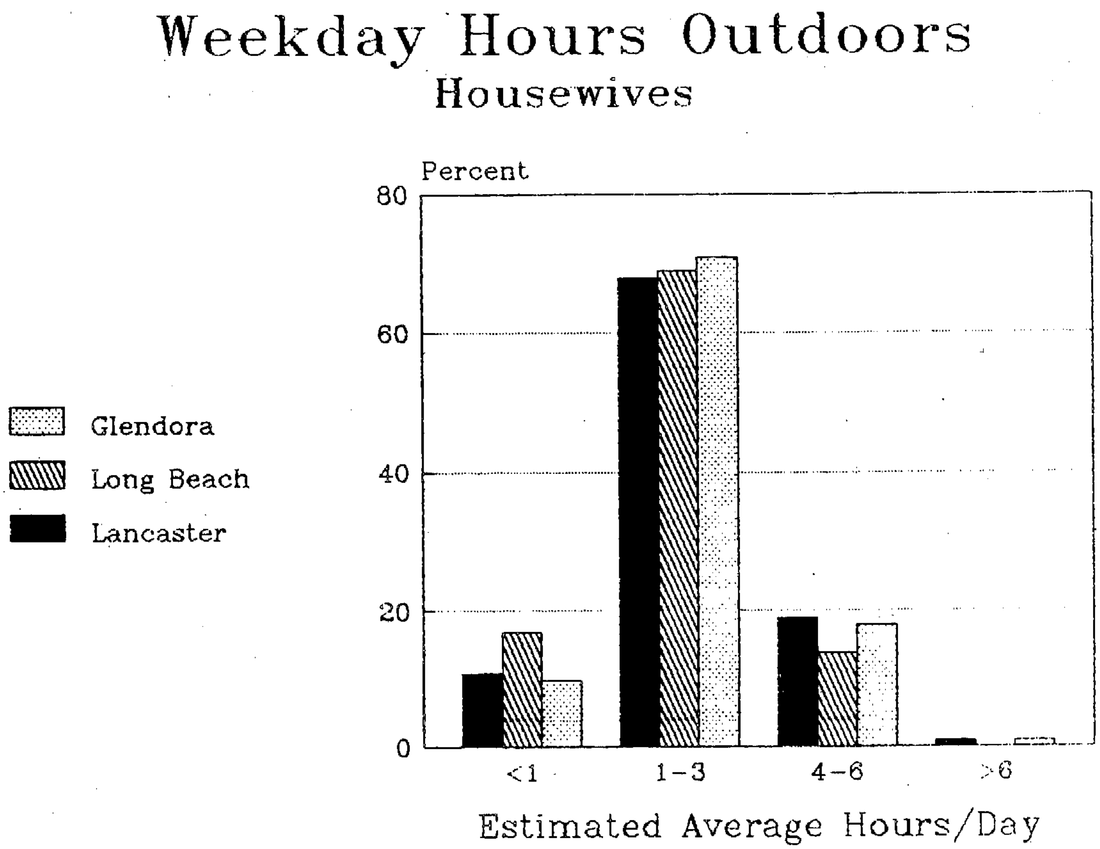


Figure 1b


Weekday Hours Outdoors
Housewives
Percent
80
60
40
20
0
Glendora
Long Beach
Lancaster
<1
1-3
4-6
>6
Estimated Average Hours/Day

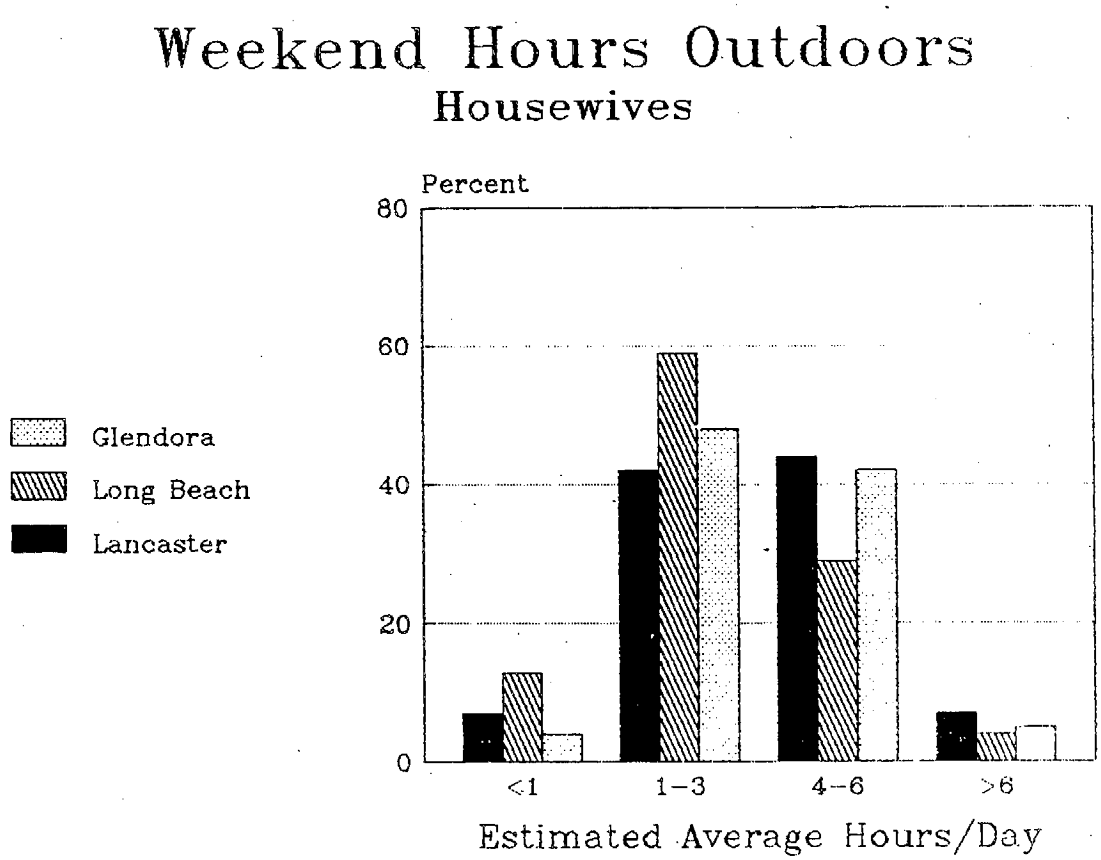
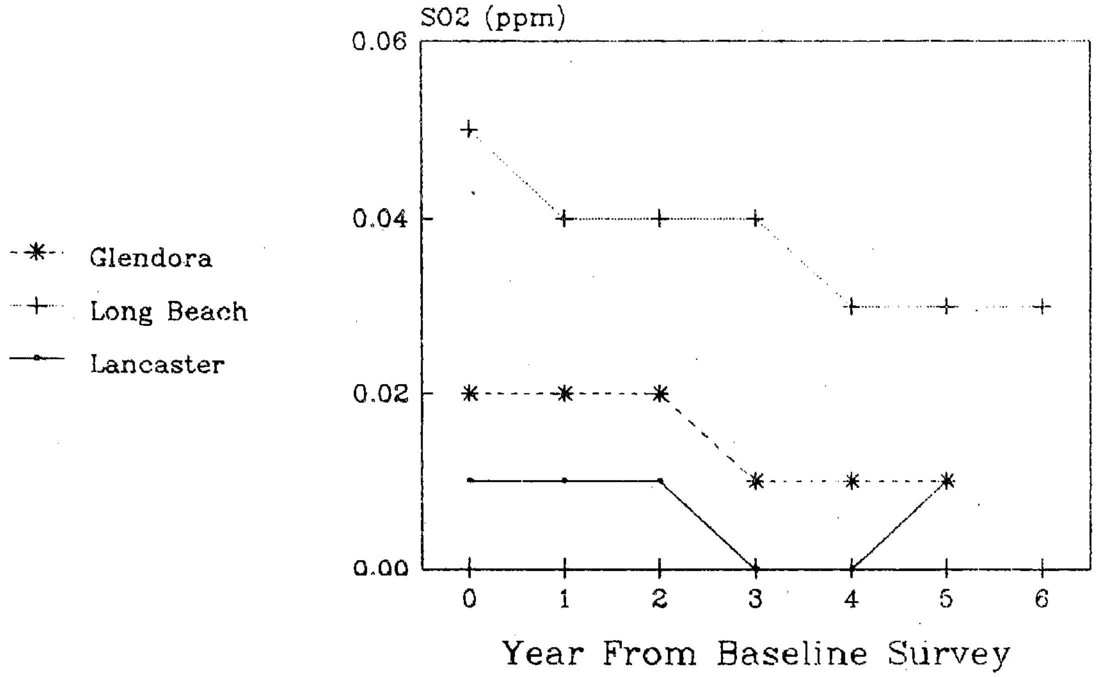

Weekend Hours Outdoors
Housewives
Percent
80
60
40
20
0
Glendora
Long Beach
Lancaster
<1
1-3
4-6
>6
Estimated Average Hours/Day

Figure 1c

Annual Means of Daily Maximum
Sulfur Dioxide



Methods change over time and city

Annual Means of Daily Maximum
Sulfates

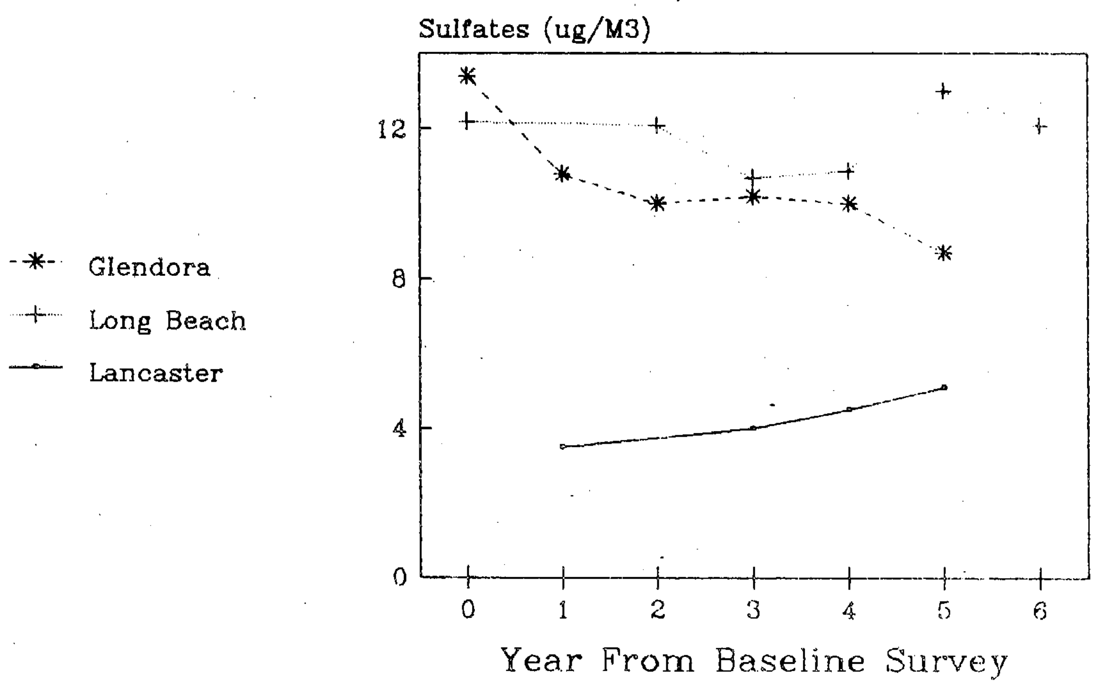
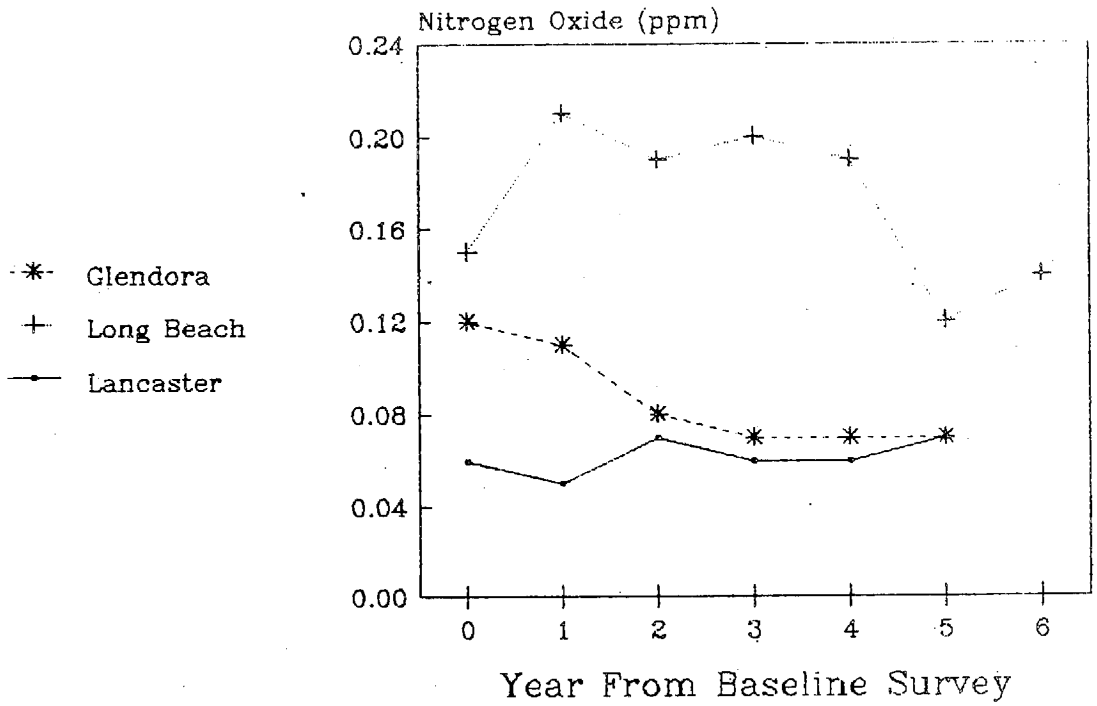


Figure 2a
24 Hour Totals

Annual Means of Daily Maximum
Nitrogen Oxide



Annual Means of Daily Maximum
Nitrogen Dioxide

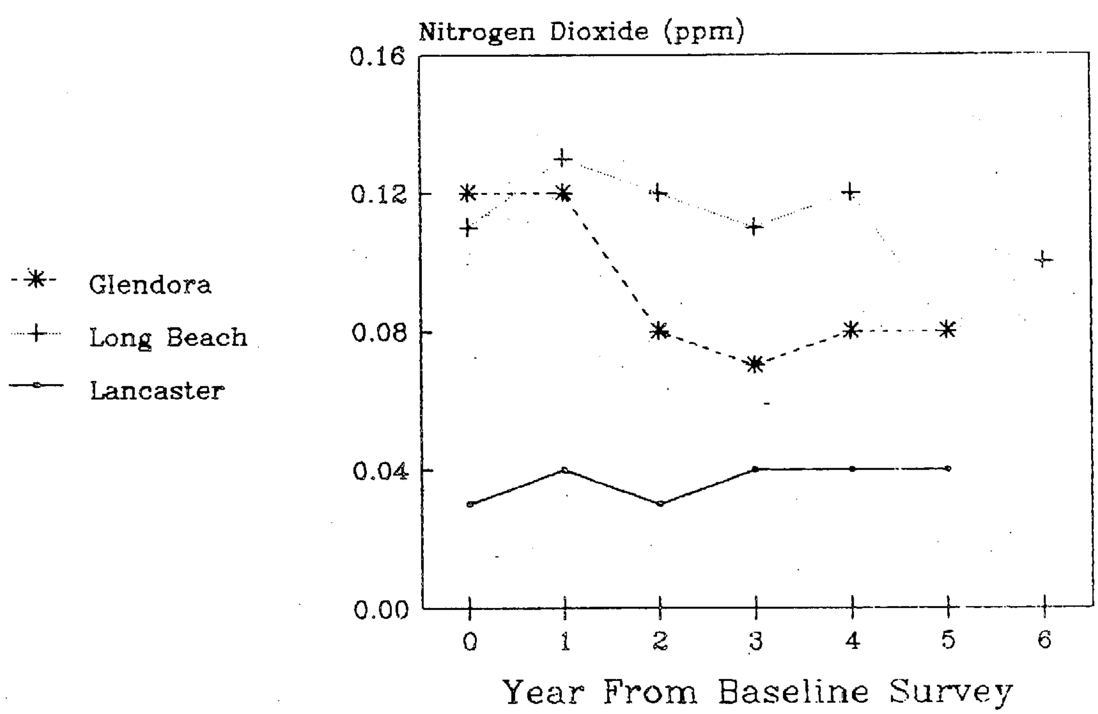
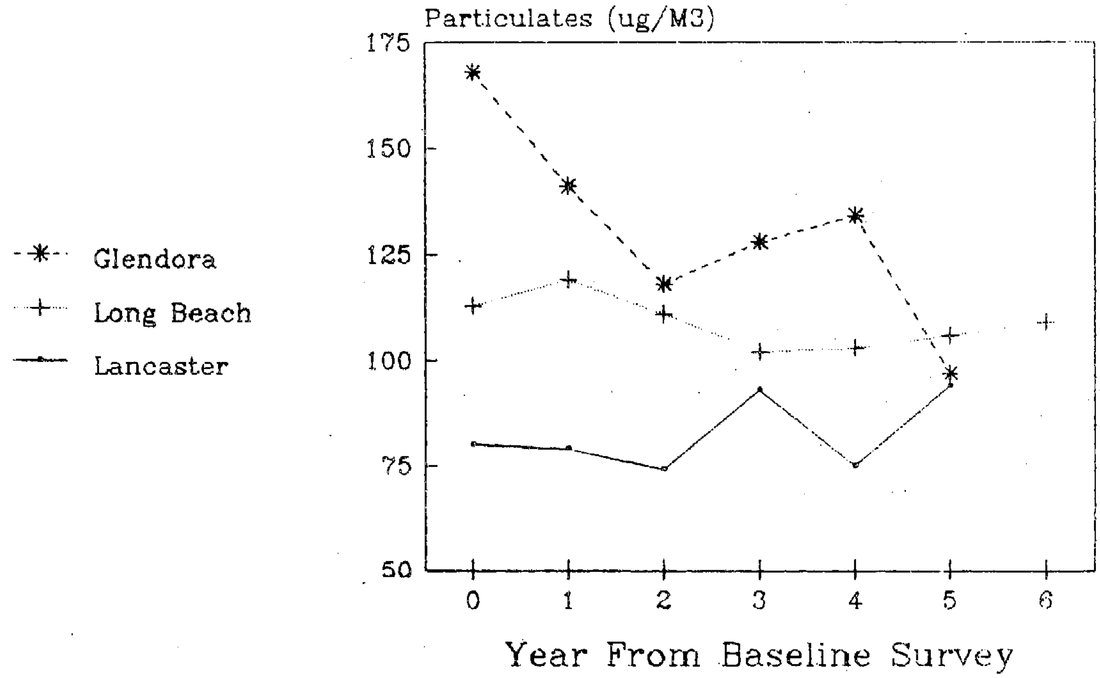


Figure 2b

Annual Means of Daily Maximum
Particulates



24 Hour Totals

Annual Means of Daily Maximum
Oxidants

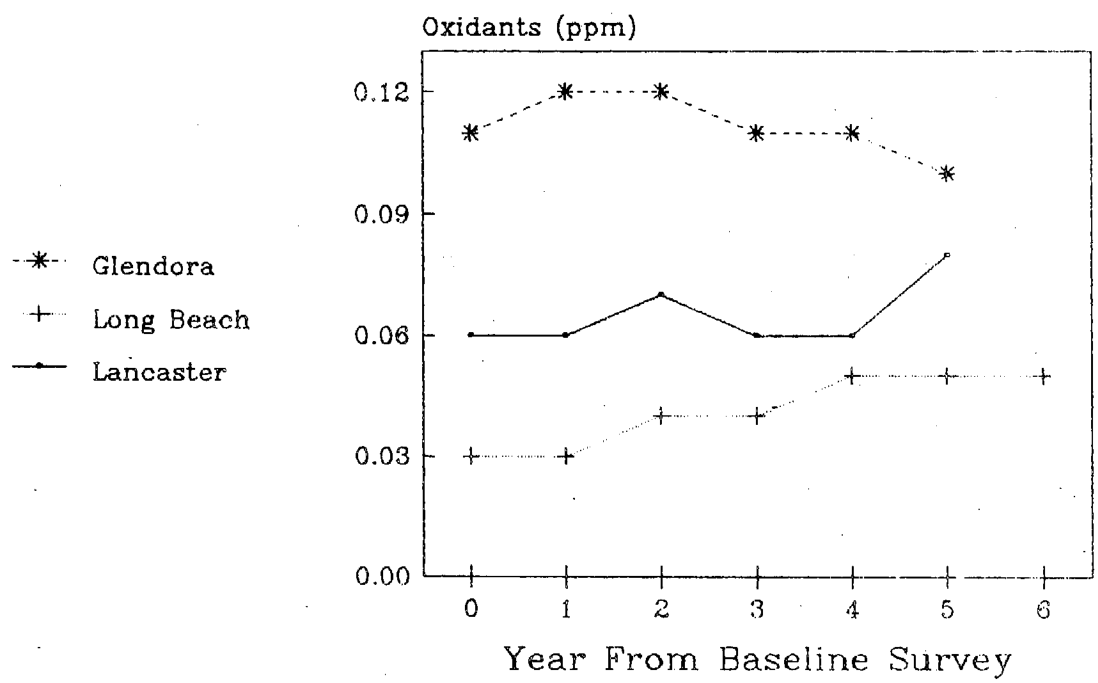


Figure 2c

From 1979 values are for ozone

APPENDIX A

BASELINE QUESTIONNAIRE (1977)

Card 0 3 (1 2)   UCLA I.D. ____ (3 4 5 6 7) ____ (8 9)   MLRL I.D. ____ (10 11 12 13 14)

ENVIRONMENTAL EFFECTS EVALUATION PROGRAM

Interview Schedule

NAME ______________________   Relation to Head [ ] 16

Address ______________________   Telephone Number ______________
(Street address only)

Sex: 1 Male 2 Female [ ] 17   BIRTHDATE: Mo. [ ][ ] 18 19 Day [ ][ ] 20 21 Year [ ][ ] 22 23   BIRTHPLACE: [ ][ ] 24 25

City: ______________

Name of Interviewer ______________________ [ ] 26   State: ______________

Informant: 1 Subject 2 Parent 3 Guardian 4 Other relative 5 Other [ ] 27

Race/Ethnicity: [ ] 28
1 White
2 Black
3 Spanish Surname
4 Chinese
5 Japanese
6 Other (specify)
____
____

Date of Interview: Mo. [ ][ ] 29 30 Day [ ][ ] 31 32 Yr. [ ] 33   Time of Interview: [ ][ ] 34 35

Preamble: I am first going to ask you some questions about your respiratory health.
(INTERVIEWER: Note that all N/A responses receive a code of "9")

A. COUGH (All questions must be asked)

1. Do you usually cough first thing in the morning in bad weather? 1 Yes 2 No [ ] 36

2. Do you usually cough at other times during the day or night in bad weather? 1 Yes 2 No [ ] 37

3. Do you cough on most days for as much as 3 months of the year? 1 Yes 2 No [ ] 38

4. Do you cough first thing in the morning (when you get up) on more than 50 days in a year? 1 Yes 2 No [ ] 39

(If no cough reported, code 9 for col. 40)

IF cough is reported, ask:

5. For how many years have you had this cough? [ ] 40

(9) N/A
1. one yr. or less
2. 2 to 5 years
3. 6 to 10 years
4. More than 10 years

B. <u>SPUTUM</u> (All questions must be asked. If YES to any SPUTUM questions, ask Q.11)

6. Do you usually bring up phlegm, sputum or mucous from your chest first thing in the morning in bad weather? 1 Yes 2 No [ ] 41

7. Do you usually bring up phlegm, sputum or mucous from your chest at other times during the day or night in bad weather? 1 Yes 2 No [ ] 42

8. Do you bring up phlegm, sputum or mucous from your chest on most days for as much as 3 months of the year? 1 Yes 2 No [ ] 43

9. Do you bring up any phlegm from your chest first thing in the morning on more than 50 days in a year? 1 Yes 2 No [ ] 44

10. Do you bring up any phlegm from your chest later in the day on more than 50 days in a year? 1 Yes 2 No [ ] 45

11. For how many years have you raised phlegm, sputum or mucous from your chest? [ ] 46

(9) N/A
1. one yr. or less
2. 2 to 5 years
3. 6 to 10 years
4. 10 yrs. or more

(INTERVIEWER: If subject reports neither cough nor phlegm, code 9 for cols. 47-48, and ask question 13.)

12. Does most of this coughing (or phlegm) come during just one season of the year? (INTERVIEWER: Check 1. cough 2. phlegm 3. cough and phlegm) [ ] 47

(9) N/A
1. Summer
2. Fall
3. Winter
4. Spring
5. None.

[ ] 48

13. In the past three years have you had a period of INCREASED cough and phlegm lasting for three weeks or more? 1 Yes 2 No [ ] 49

14. Have you had more than one such period? 1 Yes 2 No 9 N/A [ ] 50

C. WHEEZING

15. Does your breathing ever sound wheezing or whistling? 1 Yes 2 No [ ] 51

(INTERVIEWER: If no, col. 52 coded 9; ask question 17.)

16. On how many days has this happened during the past year?

(9) N/A
1. less than 5
2. 5 to 10
3. 10 to 20
4. 20 to 50
5. over 50

[ ] 52

17. Have you ever had attacks of shortness of breath with wheezing? 1 Yes 2 No [ ] 53

D. BREATHLESSNESS

18. Are you troubled by shortness of breath when hurrying on level ground or walking up a slight hill? 1 Yes 2 No [ ] 54

(INTERVIEWER: If NO, cols. 55 and 56 are coded 9, skip to Q.21.)

19. Do you get short of breath walking with other people of your own age on level ground? 1 Yes 2 No 9 N/A [ ] 55

20. Do you have to stop for breath when walking at your own pace on level ground? 1 Yes 2 No 9 N/A [ ] 56

21. Do you suddenly become short of breath when taking it easy (not exercising)? 1 Yes 2 No [ ] 57

IF yes to 21, ask:

22. On how many days did this happen during the past year? [ ] 58

- (9) N/A
- 1. less than 5
- 2. 5 to 10
- 3. 10 to 20
- 4. 20 to 50
- 5. over 50

23. INTERVIEWER: Does subject appear to be disabled (crippled) by reason other than shortness of breath? Note here ______________________ (no code) 1 Yes 2 No [ ] 59

24. Do you now have ANY serious illness? 1 Yes 2 No [ ] 60

If yes, note here ______________________ (no code)

E. CHEST ILLNESS

25. During the past 3 years, how much trouble have you had with illnesses such as chest colds, bronchitis or pneumonia? [ ] 61

- 1. great deal of trouble
- 2. some trouble
- 3. no trouble

IF a great deal or some trouble, ask:

26. During the past 3 years, how often were you unable to do your usual activities because of illness such as chest colds, bronchitis or pneumonia? [ ] 62

- (9) N/A
- 1. one time
- 2. 2 to 5 times
- 3. more than 5 times

27. Has a doctor ever told you that you had asthma, chronic bronchitis, or emphysema?

1 Yes　2 No　[ ] 63

(INTERVIEWER: If no, cols. 64-71 are coded "9"; go to question 34)

28. If yes, which one(s)?

(9) N/A
1 Asthma
2 Chronic Bronchitis
3 Emphysema
4 Asthma & Bronchitis
5 Emphysema & Bronchitis
6 Asthma & Emphysema
7 All three illnesses

[ ] 64

29. Are you now taking medicine for this?

1 Yes　2 No　(9) N/A　[ ] 65

30. If yes, for which one(s)? (Use code above) . . . . [ ] 66

31. Have you taken any medication for asthma, bronchitis, or emphysema in the last 6 hours?

1 Yes　2 No　(9) N/A　[ ] 67

32. If yes, what is the name of the medication(s)?

____

____

1 Antibiotics
2 Bronchodilators
3 Steroid
4 Other ____________
(9) Not specified

[ ] 68

33. If no, at what age was your last experience with this disease?

1	0-5 yrs.	6	40-49 yrs.
2	6-11 yrs.	7	50-59 yrs.
3	12-17 yrs.	8	60+ yrs.
4	18-29 yrs.	(9)	N/A
5	30-39 yrs.		

Asthma	Bronc.	Emphy.
[ ] 69	[ ] 70	[ ] 71

34. Do you <u>think</u> you have ever had any of these chest disorders: asthma, any kind of bronchial trouble, or emphysema?

1 Yes
2 No
3 I don't know

☐ 72

35. Have any of your "blood relatives" ever had persistent asthma, bronchitis, or emphysema?

1 Yes 2 No

☐ 73

36. Has a doctor ever told you that you had TB or any OTHER CHRONIC lung condition?

1 Yes, TB
2 Yes, other
3 No

☐ 74

If yes, note condition ______________________ (no code)

37. Have you had treatment for this?

1 Yes 2 No (9) N/A

☐ 75

38. Has the doctor ever told you that you had an allergic disease?

If YES, what is the allergic disease?

1 Eczema
2 Hayfever
3 Hives
4 Asthma
5 Allergic Conjunctivitis
6 Other ______________
(9) N/A

☐ 76

39. Do you have cold or flu symptoms now?

1 Yes 2 No

☐ 77

40. If no, when did you last have cold or flu symptoms?

1 1 - 3 days ago
2 4 - 7 days ago
3 1 - 3 weeks ago
4 4 - 6 weeks ago
5 more than 6 weeks ago
(9) N/A

☐ 78

F. SMOKING

41. Do you now smoke cigarettes regularly, occasionally or never? (INTERVIEWER: ask about little cigars or brown cigarettes)

1 regularly
2 occasionally (code 9 for cols. 80 & 10-19 if usually less than one per day)
3 never (code 9 for 80 & 10-19)

[ ] 79

42. Do you inhale?

1 Yes 2 No (9) N/A

[ ] 80

Card [C][4] 1 2

UCLA I.D. [ ][ ][ ][ ][ ][ ][ ] 3 4 5 6 7 8 9

43. Do you smoke cigarettes with filters or without filters?

(9) N/A
1 with filters
2 without filters
3 smoke both

[ ] 10

44. How many cigarettes do you usually smoke each day at the present time?

(9) N/A
1 less than 5
2 5 to 10
3 11 to 15
4 16 to 20
5 21 to 30
6 over 30

[ ] 11

45. In past years, did you usually smoke more cigarettes than you do at present?

1 Yes 2 No (9) N/A

[ ] 12

46. If yes, what was the usual number you smoked then? (Please give best estimate)

(9) N/A
1 less than 5
2 5 to 10
3 11 to 15
4 16 to 20
5 21 to 30
6 over 30

[ ] 13

47. Have you ever attempted to stop smoking?

1 Yes 2 No (9) N/A

[ ] 14

48. If yes, what was the longest period of time you were able to stop? ____________

1 Days
2 Weeks
3 Months
4 Years

Time Unit [ ] 15

Number [ ][ ] 16 17

49. How old were you when you began to smoke cigarettes? (99) N/A [ ][ ] Yrs. 18 19

(Interviewer: Record age in years)

(INTERVIEWER: If Subject is presently smoking, code 9 for cols. 20-27 and ask question 57 .)

50. If you do not smoke cigarettes now, did you ever smoke them regularly or occasionally? [ ] 20

(9) N/A
1. regularly
2. occasionally (code 9 for 21-27 if usually less than one per day)
3. never smoked cigarettes (code 9 for 21-27)

51. What was the usual number of cigarettes you smoked per day? [ ] 21

(9) N/A
1. less than 5
2. 5 to 10
3. 11 to 15
4. 16 to 20
5. 21 to 30 (1-1½ packs)
6. over 30

52. Did you inhale? 1. Yes 2. No (9) N/A [ ] 22

53. Most of the time that you smoked did you smoke cigarettes with filters or without filters? [ ] 23

(9) N/A
1. with filters
2. without filters
3. smoke both

54. How old were you when you stopped smoking cigarettes regularly? (99) N/A [ ][ ] Yrs. 24 25

(Interviewer: Record age in years)

55.	What was the main reason you stopped smoking?	(9) N/A 1 doctor's advice 2 advice of others 3 fear of health effects 4 other (specify) ______	[ ] 26
56.	Were you also influenced to stop because you had a cough, wheezing or shortness of breath?	1 Yes 2 No (9) N/A	[ ] 27
57.	Do you now smoke pipes or cigars regularly, occasionally or never?	1 regularly 2 occasionally (code 9 for 29-33 if usually less than one per day) 3 never (code 9 for 29-33)	[ ] 28
58.	Which do you smoke?	(9) N/A 1 pipe 2 cigar 3 both	[ ] 29
59.	How many pipefuls or cigars do you usually smoke each day? No. of pipefuls ______ No. of cigars ______	(9) N/A 1 less than 5 2 5 to 10 3 10 to 15 4 over 15	[ ] 30
60.	How old were you when you first smoked pipes or cigars? (INTERVIEWER: Record age in years)	(99) N/A	[ ][ ] Yrs. 31 32
61.	Do you usually inhale when you smoke pipes or cigars?	1 Yes 2 No (9) N/A	[ ] 33

(INTERVIEWER: If Subject is presently smoking pipe or cigars, code 9 for cols. 34-38 and ask question 66.)

62. If you do not smoke pipes or cigars now, did you ever smoke them regularly or occasionally?

(9) N/A
1. regularly
2. occasionally (code 9 for 35-38 if usually less than one per day)
3. never (code 9 for 35-38)

☐ 34

63. How many pipefuls or cigars did you usually smoke each day?

No. of pipefuls ____________

No. of cigars ____________

(9) N/A
1. less than 5
2. 5 to 10
3. 10 to 15
4. over 15

☐ 35

64. How old were you when you stopped smoking pipes or cigars? (99) N/A ☐☐ 36 37

65. Did you usually inhale when you smoked either pipes or cigars? 1 Yes 2 No 9 N/A ☐ 38

66. FOR SMOKERS ONLY: How long has it been since your last: 1 Cigarette 2 Pipe 3 Cigar 9 N/A ☐ 39

(Record time in minutes - highest is 600) Minutes ☐☐☐ 40 41 42

PREAMBLE: I am now going to ask you some questions about your education, residential and work history.

G. OCCUPATION

67. Are you presently employed? 1 = Yes, full-time 2 = Yes, part-time

If NO:

3 = Student (22 or under) 4 = Student (22+)

5 = Housewife 6 = Unemployed

7 = Retired for health reasons 8 = Retired

[ ] 43

68. What is your present occupation?

(INTERVIEWER: If Q.67 coded 3 to 8, record the last occupation held, if any; if none, cols. 44-74 are coded 9.)

Kind of business or industry ______________________

Work [ ][ ] 44 45

Kind of work done ______________ Location ______________

**Location [ ][ ] 46 47 #Time [ ] 48

Dates of employment: From ____________ to ______________

69. How far do you live from your place of work? (Record no. of miles)

Miles [ ][ ] 49 50

70. How do you get to your place of work?

1. Automobile
2. Bus
3. Walk
4. Other

[ ] 51

71. How much time do you spend travelling to and from work each day? (Record time in minutes)

Minutes [ ][ ][ ] 52 53 54

** Location Code - See map of APCD source areas.

72. Does your job involve travelling from one place to another during the work day? 1. Yes 2. No (9) N/A [ ] 55

73. If yes, where do you travel to? ______ (Use Location Code on APCD source area map.) **Location [ ][ ] 56 57

74. How much time do you spend in travelling to these other locations? (Record time in minutes) Minutes [ ][ ][ ] 58 59 60

Now, I'm going to ask you some questions about your work schedule.

75. Do you usually work days, evenings or nights? [ ] 61

1. Days (6AM-6PM)
2. Evenings (3PM-12AM)
3. Nights (9PM-6AM)
4. Other ______ (specify)

76. What days of the week do you work? [ ] 62

1. Mon-Fri only
2. Sat & Sun + 3 other days
3. Other combination

77. How much time do you spend at your work location on an average day? (Record time spent in hours.) Hours [ ][ ] 63 64

78. While at work, how much time do you spend outdoors on an average day? (Record time spent in hours.) Hours [ ] 65

** Location Code - See map of APCD source areas.

Card No. 0 5
1 2

UCLA ID No.
3 4 5 6 7 8 9

82. At your place of work, are there any air modifiers, such as air conditioners, humidifiers, or filters?

1 Yes
2 No
3 I don't know
(9) N/A

10

83. Have you ever worked at a job in which you noticed changes in your breathing ability? (e.g. shortness of breath, more coughing or sneezing than usual, greater incidence of chest colds?)

1 Yes
2 No
(9) N/A

11

IF YES:

Kind of business or industry: ____________________ Work 12 13

Kind of work done: ____________________

Dates of employment: From __________ to __________ #Time 14

84. Have you ever changed occupations because of a breathing (lung) problem?

1 Yes
2 No
(9) N/A

15

IF YES: Kind of business or industry: ____________________ Work 16 17

Kind of work done: ____________________

Dates of employment: From __________ to __________ #Time 18

I am now going to read several lists concerning materials you may have worked with as well as jobs you may have held. When I come to an item that applies to you, please tell me the number of months or years appropriate to that item. If any of the items apply to your work while in military service, please include them.

(INTERVIEWER: Code months as nearest quarter fraction (e.g. 1/4, 1/2, 3/4) of year and add to total)

82. Have you ever worked at a job handling any of the following materials?

(INTERVIEWER: If more than one material is named, ask if the materials were on the same or different jobs.)

1	Paints and solvents	____ yrs.	8	Tobacco leaves	____ yrs.	Material [ ][ ] 10 11	Years [ ][ ] 12 13
2	Dry cleaner for clothes	____ yrs.	9	Handling fluorescent lights	____ yrs.	[ ][ ] 14 15	[ ][ ] 16 17
3	Gasoline and oils	____ yrs.	10	Asbestos	____ yrs.	[ ][ ] 18 19	[ ][ ] 20 21
4	Asphalt and tar	____ yrs.	11	X-ray equipment	____ yrs.	[ ][ ] 22 23	[ ][ ] 24 25
5	Creosote	____ yrs.	12	Fiberglass	____ yrs.		
6	Dyes and stains	____ yrs.	13	Plastics	____ yrs.		
7	Crop dusts and sprays	____ yrs.	14	Powders	____ yrs.		

Total no. of materials handled [ ][ ] 26 27

Total years [ ][ ] 28 29

83. Have you ever worked in a:

1	Steel mill	[ ][ ] 30 31 yrs.
2	Smelter or Foundry (If yes, ask #3)	[ ][ ] 32 33 yrs.
4	Grain elevator or silo	[ ][ ] 37 38 yrs.
5	Chemical plant (If yes, ask #6)	[ ][ ] 39 40 yrs.
7	Road construction or maintenance crew	[ ][ ] 44 45 yrs.
8	On a farm or ranch	[ ][ ] 46 47 yrs.
9	Textile mill (if yes, ask #10)	[ ][ ] 48 49 yrs.

3 What metal(s)? ____________

Number of Metals [ ] 34 — Metals [ ] 35 [ ] 36

6 What chemical(s)? ____________

Number of Chemicals [ ] 41 — Chemicals [ ] 42 [ ] 43

10 What textile(s)? ____________

Number of Textiles [ ] 50 — Textiles [ ] 51 [ ] 52

Total years [ ][ ] 53 54

109

84. Have you ever worked as a:

1 Fry cook ______ yrs.

2 Miner (If yes, ask #3) ______ yrs.

3 What kind of mining? ____________

4 Carpenter or sawmill worker ______ yrs.

5 Mechanic (any type) ______ yrs.

6 Sand blaster ______ yrs.

7 Metal worker (If yes, ask #8) ______ yrs.

8 What metal(s)? ____________

9 Welder ______ yrs.

10 Stone worker ______ yrs.

11 Cotton ginner ______ yrs.

12 Beautician ______ yrs.

13 Baker ______ yrs.

14 Plasterer ______ yrs.

Job	Years
55 56	57 58
59 60	61 62
63 64	65 66

Total no. of jobs ☐☐ 67 68

Total years ☐☐ 69 70

Mining ☐ 71

Metals ☐☐ 72 73

85. Have you ever worked at any other dusty job?

1 Yes 2 No ☐ 74

What job? ______________ Years ________

Years ☐☐ 75 76

Card No. 0 6 (1 2)

UCLA I.D. ☐☐☐☐☐☐☐ 3 4 5 6 7 8 9

H. DEMOGRAPHIC

86. What is the highest grade (or year) of regular school that you have completed? (Code numerically, e.g., completed 8th grade = 08; completed high school = 12; college graduate = 16. Code all degrees beyond the level of college graduate as 18.) [ ][ ] 10 11

87. What is your social security number? SS# [ ][ ][ ] [ ][ ] [ ][ ][ ][ ] 12 13 14 15 16 17 18 19 20

88. How long have you lived in Glendora? (Record no. of years.) Yrs. [ ][ ] 21 22

89. How long have you lived in the East San Gabriel Valley? (Record years.) Yrs. [ ][ ] 23 24

90. Have you ever lived outside the East San Gabriel Valley for one year or more at a time? (Please include military service and residence overseas.) 1. Yes 2. No [ ] 25

If NO to Q.90, cols. 26-75 are coded 9.

If YES to Q.90, ask:

<u>91</u>. Have any of these places been within 50 miles of a big city (population 1/2 million or more)? 1. Yes 2. No (9) N/A [ ] 26

If YES to Q.91, ask:

<u>92</u>. Starting with your place of birth, please tell me all of these places. Please include military service and residence overseas, but do <u>not</u> include moves made within the same community.

INTERVIEWER: For "Miles to City" use the following code:

1 = 0 to 25 miles
2 = 26 to 50 miles
3 = Over 50 miles

For "Work Location" ask: Did you work in the Metropolitan City? Code: 1. Yes, 2. No, 9. N/A

	RESIDENCE	NEAREST METROPOLITAN CITY	SMSA	MILES TO CITY	WORK LOCATION	FROM AGE	TO AGE
1.			27 28	29	30	31 32	33 34
2.			35 36	37	38	39 40	41 42
3.			43 44	45	46	47 48	49 50
4.			51 52	53	54	55 56	57 58
5.			59 60	61	62	63 64	65 66
6.			67 68	69	70	71 72	73 74

How many places are listed? 75

93. Have you ever changed residence because of a breathing (lung problem? 1. Yes 2. No 76

If YES: Where did you live ______________________

How long had you lived there ______________ yrs.

How old were you when you moved ______________ yrs.

Where did you move to ______________________

Did it make a difference?

1. Yes, better
2. Yes, worse
3. No difference

14

SMSA 1 77 78 | Time 79 80

Card No. 0 7 (1 2)

UCLA ID NO. 3 4 5 6 7 8 9

Age 10 11 | SMSA 2 12 13

94. Do you presently have any type of air conditioner, humidifier or filter system in your home?

1. Yes, air cond.
2. Yes, humidifier
3. Yes, filter
4. Yes, air cond. & humid.
5. Yes, air cond. & filter
6. Yes, humid & filter
7. All three
8. None

☐ 15

95. If YES, how often is it in use?

1. Rarely
2. Occasionally
3. Often

(9) N/A

☐ 16

96. What type of heating system do you have in your home?

1. Forced air
2. Radiant
3. Floor furnace
4. Radiator (steam)
5. Other ______________ (specify)

☐ 17

97. On an average weekday (6AM-6PM, Mon-Fri), how much time do you spend in Glendora or the surrounding communities of the East San Gabriel Valley?

1. Less than 1 hr. (<10%)
2. 1 - 3 hours (11-25%)
3. 4 - 6 hours (26-50%)
4. 7 - 9 hours (51-75%)
5. More than 9 hrs. (>75%)

☐ 18

97A. On an average weekday, how much time do you spend outdoors?

(same code as above)

☐ 19

98. On an average weekend day (6AM-6PM, Sat-Sun), how much time do you spend in this area?

1. Less than 1 hr. (<10%)
2. 1 - 3 hours (11-25%)
3. 4 - 6 hours (26-50%)
4. 7 - 9 hours (51-75%)
5. More than 9 hours (>75%)

☐ 20

98A. On an average weekend day, how much time do you spend outdoors?

(same code as above)

☐ 21

Now, I am going to ask you some questions about your health.

99. Compared with other people of your age, would you say that your general state of health is worse, about the same or better?

1. Worse
2. About the same
3. Better

☐ 22

100. Thinking about the way you feel today, would you say you feel worse than usual, about the same or better than usual?

1. Worse
2. About the same
3. Better

☐ 23

101. When was the last time you saw a physician?

1. less than 6 mos. ago
2. 6 mos. to 1 year ago
3. more than 1 year ago

☐ 24

102. What was the problem? ______________________________

1. Check-up, routine
2. Acute condition (infection)
3. Accident
4. Heart
5. Respiratory ____________ specify
6. Gastrointestinal
7. Other chronic
8. Pregnancy

☐ 25

103. Which of the following describes the way you usually respond to episodes of air pollution? (You may indicate more than one.)

	Upper Respiratory	Lower Respiratory	Other
Do you experience:	___Sore throat	___Wheezing	___Eye irritation
	___Running nose	___Coughing	___Headache
	___Sneezing	___Breathlessness	___Tiredness
		___Chest tightness	___Depression
Do you usually stay in the house on smoggy days?			___Stay in

UR ☐ 26 LR ☐ 27 Other ☐ 28

104. Are you now pregnant? (If YES, how many months?)

1. No
2. 2 months
3. 3 months
4. 4 months
5. 5 mos.
6. 6 mos.
7. 7 mos.
8. 8 mos.+
(9) N/A

☐ 29

Field	Columns	Range
Ht. (in.)	30 31 . 32	30-32
Wt. (nearest lb.)	33 34 35	33-35
Blood pressure	36 37 38 / 39 40 41	36-41
$CO_{end\ exp}$	42 43 44	42-44
$CO_{ambient}$	45 46 47	45-47
N_2 Done?	48	48
begin. plateau v.	49 50 51	49-51
% N_2	52 53 . 54	52-54
750 cc % N_2	55 56 . 57	55-57
1250 cc % N_2	58 59 . 60	58-60
begin. closing v.	61 62 63 64	61-64
% N_2	65 66 . 67	65-67

Field	Columns
end closing v.	68 69 70 71
% N_2	72 73 . 74
ease of reading	75
complete tracing	76
est FVC (spirom)	77 78 79 80

Card No. 0 8 (1 2) UCLA ID (3 4 5 6 7 8 9)

BODY PLETHYSMOGRAPHY

	Open	Closed		ERV
reading 1	10 . 11 12	13 . 14 15	ERV 1 (L)	16 . 17 18 19
reading 2	20 . 21 22	23 . 24 25	ERV 2	26 . 27 28 29
reading 3	30 . 31 32	33 . 34 35	ERV 3	36 . 37 38 39
reading 4	40 . 41 42	43 . 44 45	ERV 4	46 . 47 48 49
reading 5	50 . 51 52	53 . 54 55	ERV 5	56 . 57 58 59

APPENDIX B

FOLLOWUP QUESTIONNAIRE (1982)

Card 0 3 (1 2)   UCLA I.D. ___ ___ ___ ___ ___ (3 4 5 6 7) ___ ___ (8 9)   MLRL I.D. ___ ___ ___ ___ ___ ___ (10 11 12 13 14 15)

ENVIRONMENTAL EFFECTS EVALUATION PROGRAM

Interview Schedule

Status in Program ☐ 16   Relation to Head ☐ 17

Has your address changed since the last time you participated in this program?
1 Yes
2 No ☐ 18

Sex: 1 Male
2 Female ☐ 19

Birthdate: ☐☐ 20 21 ☐☐ 22 23 ☐☐ 24 25

BIRTHPLACE: ☐☐ 26 27
City: ____________
State: ____________

Interviewer ____________ ☐ 28

Informant: ☐ 29
1 Subject
2 Parent
3 Guardian
4 Other relative
5 Other

Race/Ethnicity: ☐ 30
1 White
2 Black
3 Spanish Surnamed
4 Chinese
5 Japanese
6 Other (specify)
____
____

Date of Interview: ☐☐ 31 32 ☐☐ 33 34 ☐ 35

Time of Interview: ☐☐ 36 37

Preamble: I am first going to ask you some questions about your respiratory health.
(INTERVIEWER: Note that all N/A responses receive a code of "9")

A. COUGH (All questions must be asked)

1. Do you usually cough first thing in the morning in bad weather? 1 Yes 2 No ☐ 38

Card [0][9] (1 2)   UCLA I.D. [ ][ ][ ][ ][ ] (3 4 5 6 7) [ ][ ] (8 9)   MLRL I.D. [ ][ ][ ][ ][ ][ ] (10 11 12 13 14 15)

ENVIRONMENTAL EFFECTS EVALUATION PROGRAM

NAME: Last (16 17 18 19 20 21 22 23 24 25 26 27 28 29)   First (30 31 32 33 34 35 36 37 38 39)   Middle Initial (40)

STREET ADDRESS (41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70)

SEX: 1 Male
2 Female
[ ] (71)

YEAR OF BIRTH [ ][ ] (72 73)

DATE OF INTERVIEW Mo. [ ][ ] (74 75) Day [ ][ ] (76 77) Yr. [ ] (78)

Card No. [1][9] (1 2)   UCLA I.D. [ ][ ][ ][ ][ ] (3 4 5 6 7) [ ][ ] (8 9)   MLRL I.D. [ ][ ][ ][ ][ ][ ] (10 11 12 13 14 15)

CITY (16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31)

STATE (32 33)

ZIP (34 35 36 37 38)

Rev. pril 1982 - Glendora

2. Do you usually cough at other times during the day or night in bad weather? 1 Yes 2 No [ ] 39

3. Do you cough on most days for as much as 3 months of the year? 1 Yes 2 No [ ] 40

4. Do you cough first thing in the morning (when you get up) on more than 50 days in a year? 1 Yes 2 No [ ] 41

(If no cough reported, code 9 for col. 42)

If cough is reported, ask:

5. For how many years have you had this cough? [ ] 42

(9) N/A
1. Less than 2 years
2. 2 to 5 years
3. 6 to 10 years
4. More than 10 years

B. <u>SPUTUM</u> (All questions must be asked. If YES to any SPUTUM questions, ask Q.11)

6. Do you usually bring up phlegm, sputum or mucous from your chest first thing in the morning in bad weather? 1 Yes 2 No [ ] 43

7. Do you usually bring up phlegm, sputum or mucous from your chest at other times during the day or night in bad weather? 1 Yes 2 No [ ] 44

8. Do you bring up phlegm, sputum or mucous from your chest on most days for as much as 3 months of the year? 1 Yes 2 No [ ] 45

9. Do you bring up any phlegm from your chest first thing in the morning on more than 50 days in a year? 1 Yes 2 No [ ] 46

10. Do you bring up any phlegm from your chest later in the day on more than 50 days in a year? 1 Yes 2 No [ ] 47

11. For how many years have you raised phlegm, sputum or mucous from your chest? [ ] 48

(9) N/A
1. Less than 2 years
2. 2 to 5 years
3. 6 to 10 years
4. 10 yrs. or more

(INTERVIEWER: If subject reports neither cough nor phlegm, code 9 for cols. 49-50 , and ask question 13.)

12. Does most of this coughing (or phlegm) come during just one season of the year? (INTERVIEWER: Check
1. cough
2. phlegm
3. cough and phlegm

[ ] 49

(9) N/A
1. Summer
2. Fall
3. Winter
4. Spring
5. Fall & Winter
6. Spring & Fall
7. Winter & Spring
8. All the time

[ ] 50

13. In the past three years have you had a period of INCREASED cough and phlegm lasting for <u>three weeks</u> or more? 1 Yes 2 No [ ] 51

14. Have you had more than one such three week period? 1 Yes 2 No (9) N/A [ ] 52

C. <u>WHEEZING</u>

15. Does your breathing ever sound wheezing or whistling? 1 Yes 2 No [ ] 53

(INTERVIEWER: If no, col. 54 coded 9; ask question 17.)

16. On how many days has this happened during the past year?

(9) N/A
1. less than 5
2. 5 to 10
3. 11 to 20
4. 21 to 50
5. over 50

[ ] 54

17. Have you ever had attacks of shortness of breath with wheezing? 1 Yes 2 No [ ] 55

D. **BREATHLESSNESS**

18. Are you troubled by shortness of breath when hurrying on level ground or walking up a slight hill? — 1 Yes 2 No — [ ] 56

(INTERVIEWER: If NO, cols. 57 and 58 are coded 9, skip to Q.21.)

19. Do you get short of breath walking with other people of your own age on level ground? — 1 Yes 2 No (9) N/A — [ ] 57

20. Do you have to stop for breath when walking at your own pace on level ground? — 1 Yes 2 No (9) N/A — [ ] 58

21. Do you suddenly become short of breath when taking it easy (not exercising)? — 1 Yes 2 No — [ ] 59

IF yes to 21, ask:

22. On how many days did this happen during the past year? — [ ] 60

(9) N/A
1. less than 5
2. 5 to 10
3. 10 to 20
4. 20 to 50
5. over 50

23. INTERVIEWER: Does subject appear to be disabled (crippled) by reason other than shortness of breath? Note here ____________ — 1 Yes 2 No — [ ] 61

24. Do you now have ANY serious illness? Note here ____________ — 1 Yes 2 No — [ ] 62

E. **CHEST ILLNESS**

25. During the past 3 years, how much trouble have you had with illnesses such as chest colds, bronchitis or pneumonia? — [ ] 63

1. great deal of trouble
2. some trouble
3. no trouble

IF a great deal or some trouble, ask:

26. During the past 3 years, how often were you unable to do your usual activities because of illness such as chest colds, bronchitis or pneumonia? — [ ] 64

(9) N/A
1. one time
2. 2 to 5 times
3. more than 5 times
4. no times

27. Has a doctor ever told you that you had asthma, chronic bronchitis, or emphysema? 1 Yes 2 No [ ] 65

(INTERVIEWER: If no, cols. 66-75 are coded "9"; go to question 35)

28. If yes, which one(s)?

(9) N/A
1 Asthma
2 Chronic Bronchitis
3 Emphysema
4 Asthma & Bronchitis
5 Emphysema & Bronchitis
6 Asthma & Emphysema
7 All three illnesses

[ ] 66

29. At what age was this first diagnosed? (Record age in years) . . . . [ ][ ] yrs 67 68

30. Have you taken medicine or treatment for this in the last year? 1 Yes 2 No (9) N/A [ ] 69

31. If yes, for which one(s)? (Use code above) . . . . [ ] 70

32. Have you taken any medication for asthma, bronchitis, or emphysema in the last 6 hours? 1 Yes 2 No (9) N/A [ ] 71

33. If yes, what is the name of the medication(s)?

____

____

1 Antibiotics
2 Bronchodilators
3 Steroid
4 Other __________
(9) Not specified

[ ] 72

34. (If no to Q. 30): At what age was your last experience with this disease?

1 0-5 yrs.
2 6-11 yrs.
3 12-17 yrs.
4 18-29 yrs.
5 30-39 yrs.
6 40-49 yrs.
7 50-59 yrs.
8 60+ yrs.
(9) N/A

Asthma	Bronc.	Emphy.
[ ] 73	[ ] 74	[ ] 75

35. Do you think you have ever had any of these chest disorders: asthma, emphysema or any kind of bronchial trouble?

1. Asthma
2. Bronchitis
3. Emphysema
4. Asthma & Bronch.
5. Emphysema & Bronch.
6. Asthma & Emphysema
7. All three
8. No
9. Don't know

[ ] 76

36. Have any of your "blood relatives" ever had persistent asthma, bronchitis, or emphysema?

1 Yes
2 No
3 I don't know

[ ] 77

37. Has a doctor ever told you that you had TB or any OTHER CHRONIC lung condition?

1 Yes, TB
2 Yes, other
3 No

[ ] 78

If yes, note condition ______________________ (no code)

38. Have you had treatment for this? 1 Yes 2 No (9) N/A [ ] 79

39. Do you have an allergic disease?

If YES, what is the allergic disease?

1 Eczema
2 Hayfever
3 Hives
4 Asthma
5 Allergic Conjunctivitis
6 Other ______________
(9) N/A

[ ] 80

Card [0][4] 1 2

UCLA I.D. [ ][ ][ ][ ][ ][ ][ ] 3 4 5 6 7 8 9

40. Do you have cold or flu symptoms now? 1 Yes 2 No [ ] 10

41. If no, when did you last have cold or flu symptoms?

1 1 - 3 days ago
2 4 - 7 days ago
3 1 - 3 weeks ago
4 4 - 6 weeks ago
5 more than 6 weeks ago
(9) N/A

[ ] 11

F. SMOKING

42. Do you now smoke cigarettes regularly, occasionally or never? (INTERVIEWER: ask about little cigars or brown cigarettes)

1 regularly
2 occasionally (code 9 for cols. 13-23 if usually less than one per day)
3 never (code 9 for 13-23) — 12

43. Do you inhale?

1 Yes 2 No (9) N/A — 13

44. Do you smoke cigarettes with filters or without filters?

(9) N/A
1 with filters
2 without filters
3 smoke both — 14

45. How many cigarettes do you usually smoke each day at the present time?

(9) N/A
1 less than 5 4 16 to 20
2 5 to 10 5 21 to 30
3 11 to 15 6 over 30 — 15

46. In past years, did you usually smoke more cigarettes than you do at present?

1 Yes 2 No (9) N/A — 16

47. If yes, what was the usual number you smoked then? (Please give best estimate)

(9) N/A
1 less than 5 4 16 to 20
2 5 to 10 5 21 to 30
3 11 to 15 6 over 30 — 17

48. Have you ever attempted to stop smoking?

1 Yes 2 No (9) N/A — 18

49. If yes, what was the longest period of time you were able to stop? ____________________

1 Days
2 Weeks
3 Months
4 Years

Time Unit — 19

Number — 20 21

50. How old were you when you began to smoke cigarettes?

(Interviewer: Record age in years)

(99) N/A — Yrs. 22 23

(INTERVIEWER: If Subject is presently smoking, code 9 for cols. 24-33 and ask question 59.)

51. If you do not smoke cigarettes now, did you ever smoke them regularly or occasionally?

(9) N/A
1 regularly
2 occasionally (code 9 for 25-33 if usually less than one per day)
3 never smoked cigarettes (code 9 for 25-33)

24

52. What was the usual number of cigarettes you smoked per day?

(9) N/A
1 less than 5
2 5 to 10
3 11 to 15
4 16 to 20
5 21 to 30 (1-1½ packs)
6 over 30

25

53. Did you inhale?

1 Yes 2 No (9) N/A

26

54. Most of the time that you smoked did you smoke cigarettes with filters or without filters?

(9) N/A
1 with filters
2 without filters
3 smoked both

27

55. How old were you when you stopped smoking cigarettes regularly?

(Interviewer: Record age in years)

(99) N/A

Yrs. 28 29

56. How old were you when you began to smoke cigarettes?

(Interviewer: Record age in years)

(99) N/A

Yrs. 30 31

57. What was the main reason you stopped smoking?

(9) N/A
1 doctor's advice
2 advice of others
3 fear of health effects
4 other (specify) ______

32

58. Were you also influenced to stop because you had a cough, wheezing or shortness of breath?

1 Yes 2 No (9) N/A

59. Do you now smoke pipes or cigars regularly, occasionally or never?

1 regularly
2 occasionally (code 9 for 35-39 if usually less than one per day)
3 never (code 9 for 35-39)

☐ 34

60. Which do you smoke?

(9) N/A
1 pipe
2 cigar
3 both

☐ 35

61. How many pipefuls or cigars do you usually smoke each day?

No. of pipefuls ______________

No. of cigars ______________

(9) N/A
1 less than 5
2 5 to 10
3 10 to 15
4 over 15

☐ 36

62. How old were you when you first smoked pipes or cigars? (INTERVIEWER: Record age in years)

(99) N/A

☐☐ Yrs.
37 38

63. Do you usually inhale when you smoke pipes or cigars?

1 Yes 2 No (9) N/A

☐ 39

(INTERVIEWER: If Subject is presently smoking pipe or cigar, code 9 for cols. 40-46 and ask question 69.)

64. If you do not smoke pipes or cigars now, did you ever smoke them regularly or occasionally?

(9) N/A
1 regularly
2 occasionally (code 9 for 41-46 if usually less than one per day)
3 never (code 9 for 41-46)

[ ] 40

65. How many pipefuls or cigars did you usually smoke each day?

No. of pipefuls ______________

No. of cigars ______________

(9) N/A
1 less than 5
2 5 to 10
3 10 to 15
4 over 15

[ ] 41

66. How old were you when you stopped smoking pipes or cigars? (99) N/A [ ][ ] Yrs. 42 43

67. How old were you when you began to smoke pipes or cigars? (99) N/A [ ][ ] Yrs. 44 45

68. Did you usually inhale when you smoked either pipes or cigars? 1 Yes 2 No (9) N/A [ ] 46

69. FOR SMOKERS ONLY: How long has it been since your last: 1 Cigarette 2 Pipe 3 Cigar (9) N/A [ ] 47

(Record time in minutes - highest is 600)

Minutes [ ][ ][ ] 48 49 50

PREAMBLE: I am now going to ask you some questions about your education, residential and work history.

G. OCCUPATION

70. Are you presently employed? 1 = Yes, full-time 2 = Yes, part-time

If NO:

3 = Student (22 or under) 4 = Student (22+)

5 = Housewife 6 = Unemployed

7 = Retired for health reasons 8 = Retired

☐ 51

71. What is your present occupation?

(INTERVIEWER: If Q. 70 coded 3 to 8, record the last occupation held, if any within the past 10 yrs., if none, cols. 52-80 & 10-18 are coded 9.)

Kind of business or industry ______________________ Work ☐☐ 52 53

Kind of work done ______________ Zip Code Location ______________ Zip Code ☐☐☐☐☐ 54 55 56 57 58 #Time ☐ 59

Dates of employment: From ____________ to ______________

72. How far do you live from your place of work? (Record no. of miles) Miles ☐☐ 60 61

73. How do you get to your place of work?

1 Automobile
2 Bus
3 Walk
4 Other
5 Work at home

☐ 62

74. How much time do you spend travelling to and from work each day? (Record time in minutes) Minutes ☐☐☐ 63 64 65

75. Does your job involve travelling from one place to another during the work day?

1 Yes 2 No (9) N/A [ ] 66

76. If yes, where do you travel to? ______________
(Use Zip Code if one area; use code "88888" if various areas)

Zip Code [ ][ ][ ][ ][ ] 67 68 69 70 71

77. How much time do you spend in travelling to these other locations on an average day? (Record time in minutes)

Minutes [ ][ ][ ] 72 73 74

Now, I'm going to ask you some questions about your work schedule.

78. Do you usually work days, evenings or nights?

1 Days (6AM-6PM)
2 Evenings (3PM-12AM)
3 Nights (9PM-6AM)
4 Other combination ______________ (specify)

[ ] 75

79. What days of the week do you work?

1 Mon-Fri only
2 Sat & Sun + 3 other days
3 Other combination

[ ] 76

80. How much time do you spend at your work location on an average day? (Record time spent in hours.)

Hours [ ][ ] 77 78

81. While at work, how much time do you spend outdoors on an average day? (Record time spent in hours.)

Hours [ ][ ] 79 80

Card No. 0 5
1 2

UCLA ID No. 3 4 5 6 7 8 9

82. At your place of work, are there any air modifiers, such as air conditioners, humidifiers, or filters?

1 Yes
2 No
3 I don't know
(9) N/A

10

83. Have you ever worked at a job in which you noticed changes in your breathing ability? (e.g. shortness of breath, more coughing or sneezing than usual, greater incidence of chest colds?)

1 Yes
2 No
(9) N/A

11

IF YES:

Kind of business or industry: ____________________ Work 12 13

Kind of work done: ____________________ #Time

Dates of employment: From __________ to __________ 14

84. Have you ever changed occupations because of a breathing (lung) problem?

1 Yes
2 No
(9) N/A

15

IF YES: Kind of business or industry: ____________________ Work 16 17

Kind of work done: ____________________ #Time

Dates of employment: From __________ to __________ 18

I am now going to read several lists concerning materials you may have worked with as well as jobs you may have held. When I come to an item that applies to you, please tell me the number of months or years appropriate to that item. If any of the items apply to your work while in military service, please include them.

(INTERVIEWER: Code months as nearest quarter fraction (e.g. 1/4, 1/2, 3/4) of year and add to total)

85. Have you ever worked at a job handling any of the following materials?

(INTERVIEWER: If more than one material is named, ask if the materials were on the same or different jobs.)

						Material	Years
1	Paints and solvents	____ yrs.	8	Tobacco leaves	____ yrs.	19 20	21 22
2	Dry cleaner for clothes	____ yrs.	9	Handling fluorescent lights	____ yrs.	23 24	25 26
3	Gasoline and oils	____ yrs.	10	Asbestos	____ yrs.	27 28	29 30
4	Asphalt and tar	____ yrs.	11	X-ray equipment	____ yrs.	31 32	33 34
5	Creosote	____ yrs.	12	Fiberglass	____ yrs.		
6	Dyes and stains	____ yrs.	13	Plastics	____ yrs.		
7	Crop dusts and sprays	____ yrs.	14	Powders	____ yrs.		

Total no. of materials handled: 35 36

Total years: 37 38

86. Have you ever worked in a:

1	Steel mill	39 40	yrs.
2	Smelter or Foundry (If yes, ask #3)	41 42	yrs.
4	Grain elevator or silo	46 47	yrs.
5	Chemical plant (If yes, ask #6)	48 49	yrs.
7	Road construction or maintenance crew	53 54	yrs.
8	On a farm or ranch	55 56	yrs.
9	Textile mill (if yes, ask #10)	57 58	yrs.

3 What metal(s)? ____________ Number of Metals: 43 Metals: 44 45

6 What chemical(s)? ____________ Number of Chemicals: 50 Chemicals: 51 52

10 What textile(s)? ____________ Number of Textiles: 59 Textiles: 60 61

130

Total years

87. Have you ever worked as a:

1 Fry cook ______ yrs.

2 Miner (If yes, ask #3) ______ yrs.

3 What kind of mining? ____________

4 Carpenter or sawmill worker ______ yrs.

5 Mechanic (any type) ______ yrs.

6 Sand blaster ______ yrs.

7 Metal worker (If yes, ask #8) ______ yrs.

8 What metal(s)? ____________

9 Welder ______ yrs.

10 Stone worker ______ yrs.

11 Cotton ginner ______ yrs.

12 Beautician ______ yrs.

13 Baker ______ yrs.

14 Plasterer ______ yrs.

Job [ ][ ] 64 65 Years [ ][ ] 66 67

[ ][ ] 68 69 [ ][ ] 70 71

[ ][ ] 72 73 [ ][ ] 74 75

Total no. of jobs [ ][ ] 76 77

Total years [ ][ ] 78 79

Mining [ ] 80

Card No. [0][6] 1 2

UCLA ID [ ][ ][ ][ ][ ][ ][ ] 3 4 5 6 7 8 9

Metals [ ][ ] 10 11

88. Have you ever worked at any other dusty job?

1 Yes 2 No [ ] 12

What job? ____________ Years ______

Years [ ][ ] 13 14

H. DEMOGRAPHIC

89. What is the highest grade (or year) of regular school that you have completed? (Code numerically, e.g., completed 8th grade = 08; completed high school = 12; college graduate = 16. Code all degrees beyond the level of college graduate as 18.)

15 16

90. What is your social security number? SS# 17 18 19 20 21 22 23 24 25

91. Where did you spend most of your childhood? (What was the city or town?) SMSA 26 27

1 Urban 2 Rural 28

Residence Nearest Metropolitan City

92. How long have you lived in Glendora (Record cumulative no. of years) Yrs 29 30

93. Since 1977 (the last time you participated in this project), have you lived outside Glendora for one year or more at a time? (Include military service and residence overseas.) 1 Yes 2 No 31

If NO to Q.93, cols. 32-80 are coded 9.

If YES to Q.93, ask:

94. Have any of these places been within 50 miles of a big city (population 1/2 million or more?) 1 Yes 2 No 32

If YES to Q.94, ask:

95. Starting with your residence in 1977, please tell me all of these places. Please include military service and residence overseas, but do not include moves made within the same community.

INTERVIEWER: For "Miles to City" use the following code: 1 = 0 to 25 miles
2 = 26 to 50 miles
3 = Over 50 miles

For "Work Location" ask: Did you work in the Metropolitan City? Code: 1. Yes, 2. No, 9. N/A

	RESIDENCE	NEAREST METROPOLITAN CITY	SMSA	MILES TO CITY	WORK LOCATION	FROM AGE	TO AGE
1.			33 34	35	36	37 38	39 40
2.			41 42	43	44	45 46	47 48
3.			49 50	51	52	53 54	55 56
4.			57 58	59	60	61 62	63 64
5.			65 66	67	68	69 70	71 72
6.			73 74	75	76	77 78	79 80

Card No. 0 7 (1 2)

UCLA ID No. (3 4 5 6 7 8 9)

How many places are listed? ☐ 10

96. Have you ever changed residence because of a breathing (lung) problem? 1 Yes 2 No ☐ 11

If YES: Where did you live ____________ SMSA 1 (12 13) Time (14 15)

How long had you lived there ____________ yrs.

How old were you when you moved ____________ yrs. AGE (16 17) SMSA 2 (18 19)

Where did you move to ____________

Did it make a difference? 1 Yes, better
2 Yes, worse
3 No difference
☐ 20

97. Do you presently have any type of air conditioner, humidifier or filter system in your home?

1 Yes, air cond.
2 Yes, humidifier
3 Yes, filter
4 Yes, air cond & humidifier
5 Yes, air cond & filter
6 Yes, humid. & filter
7 All three
8 None

21

98. If YES, how often is it in use?

1 Rarely
2 Summer only - occasionally
3 Summer only - often
4 Yearround - occasionally
5 Yearround - often
(9) N/A

22

99. What type of heating system do you have in your home?

1 Forced air
2 Radiant
3 Floor or wall furnace (gas)
4 Radiator (steam)
5 Other ____________

23

100A. What kind of fuel is used in your home for cooking?
***(code in box 80 on page 20) ____________ Write response

100. What kind of fuel is used for heating?

1 Oil
2 Natural gas
3 Bottled gas
4 Electricity
5 Other ____________
6 Don't know

24

101. On an average <u>weekday</u> (6AM-6PM, Mon-Fri), how much time do you spend in the Glendora area?

1 Less than 1 hr. (<10%)
2 1 - 3 hours (11-25%)
3 4 - 6 hours (26-50%)
4 7 - 9 hours (51-75%)
5 More than 9 hrs. (>75%)

25

102. On an average weekday, how much of that time do you spend <u>outdoors?</u>

(same code as above)

26

103. On an average <u>weekend</u> day (6AM-6PM, Sat-Sun), how much time do you spend in this area?

1 Less than 1 hr. (<10%)
2 1 - 3 hours (11-25%)
3 4 - 6 hours (26-50%)
4 7 - 9 hours (51-75%)
5 More than 9 hrs. (>75%)

27

104. On an average weekend day, how much of that time do you spend <u>outdoors?</u>

(same code as above)

28

Now, I am going to ask you some questions about your health.

105. When was the last time you saw a physician?

1 less than 6 months
2 6 mos. to 1 year ago
3 more than 1 year ago

☐ 29

106. What was the problem? ______________________

1 Check-up, routine
2 Acute condition (infection)
3 Accident
4 Heart
5 Respiratory ______ specify
6 Gastrointestinal
7 Surgery ______ specify
8 Other ______ specify

☐ 30

107. Which of the following describes the way you usually respond to episodes of air pollution? (You may indicate more than one.)

	Upper Respiratory	Lower Respiratory	Other
Do you experience:	___Sore throat	___Wheezing	___Eye irritation
	___Running nose	___Coughing	___Headache
	___Sneezing	___Breathlessness	___Tiredness
	___Sinus irritation	___Chest tightness	___Depression

UR ☐ 31 LR ☐ 32 Other ☐ 33

108. Do you usually stay indoors on smoggy days?

1 Yes 2 No

☐ 34

109. Are you now pregnant? (If YES, how many months?)

1 No
2 2 months
3 3 months
4 4 months
5 5 months
6 6 months
7 7 months
8 8 months+
(9) N/A

☐ 35

Sta. ng Ht. (in.) [ ][ ].[ ] 36 37 . 38 — 36-38

Sitting Ht. (in.) [ ][ ].[ ] 39 40 . 41 — 39-41

Wt. (nearest lb.) [ ][ ][ ] 42 43 44 — 42-44

Blood pressure [ ][ ][ ] / [ ][ ][ ] 45 46 47 / 48 49 50 — 45-50

$CO_{end\ exp}$ [ ][ ][ ] 51 52 53 — 51-53

$CO_{ambient}$ [ ][ ][ ] 54 55 56 — 54-56

N_2

Done? [ ] 57 — 57

begin. plateau v. [ ][ ][ ] 58 59 60 — 58-60

% N_2 [ ][ ].[ ] 61 62 . 63 — 61-63

750 cc % N_2 [ ][ ].[ ] 64 65 . 66 — 64-66

1250 cc % N_2 [ ][ ].[ ] 67 68 . 69 — 67-69

1750 cc % N_2 [ ][ ].[ ] 70 71 . 72 — 70-72

begin. closing v. [ ][ ][ ][ ] 73 74 75 76 — 73-76

% N_2 [ ][ ].[ ] 77 78 . 79 — 77-79

Card No. [0][8] 1 2

[ ][ ][ ][ ][ ][ ][ ] 3 4 5 6 7 8 9

end closing v. [ ][ ][ ][ ] 10 11 12 13

% N_2 [ ][ ].[ ] 14 15 . 16

ease of reading [ ] 17

complete tracing [ ] 18

est FVC (spirom) [ ][ ][ ][ ] 19 20 21 22

BODY PLETHYSMOGRAPHY

	Open	Closed		
reading 1	23 . 24 25	26 . 27 28	ERV 1 (L)	29 30 31 32
reading 2	33 . 34 35	36 . 37 38	ERV 2	39 40 41 42
reading 3	43 . 44 45	46 . 47 48	ERV 3	49 50 51 52
reading 4	53 . 54 55	56 . 57 58	ERV 4	59 60 61 62
reading 5	63 . 64 65	66 . 67 68	ERV 5	69 70 71 72